A STUDY OF THE ANGLE FORMED BY THE DUCTUS ARTERIOSUS WITH THE DESCENDING THORACIC AORTA

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TWO FIGURES

In the literature dealing with the ductus arteriosus, there are references to the angle formed by the ductus arteriosus with the descending thoracic aorta. In fact, many students of the ductus arteriosus, such as Walkhoff (1869), Strassman (1893, '02), Faber ('12), Fromberg ('14), and Schanz (1889), have based their explanation for the physiological closure of the ductus arteriosus on the acuteness of this angle, or to a change in the degree of this angle. However, despite these references to this angle, both standard anatomical texts and the rather bulky literature dealing with the ductus arteriosus are practically devoid of any detailed description of this angle. Only two instances could be found in the literature which gave a definite numerical value of this angle. One was found in Fromberg's paper, who quoted Roux for an angle of 33°. The other is found in Faber's monograph in which the statement is made that before birth the angle is 90° and after birth it becomes more acute. Hence, it appears justifiable to make it the object of an anatomical study and accordingly such a study was pursued in the Department of Pathology of the Buffalo General Hospital and University of Buffalo.

Twenty-four infants coming to autopsy were utilized for this study, of which 14 were premature and 10 were full-term, and of the total 24 infants, 15 were stillbirths and 9 had lived anywhere from 5 hours to 15 days. The technique used was

one which would lend itself to obtaining a single rigid cast of the main pulmonary artery, ductus arteriosus and entire thoracic aorta as they exist in situ. The resultant cast was then photographed with special emphasis on the angle under investigation and the angle then measured on the photographs.

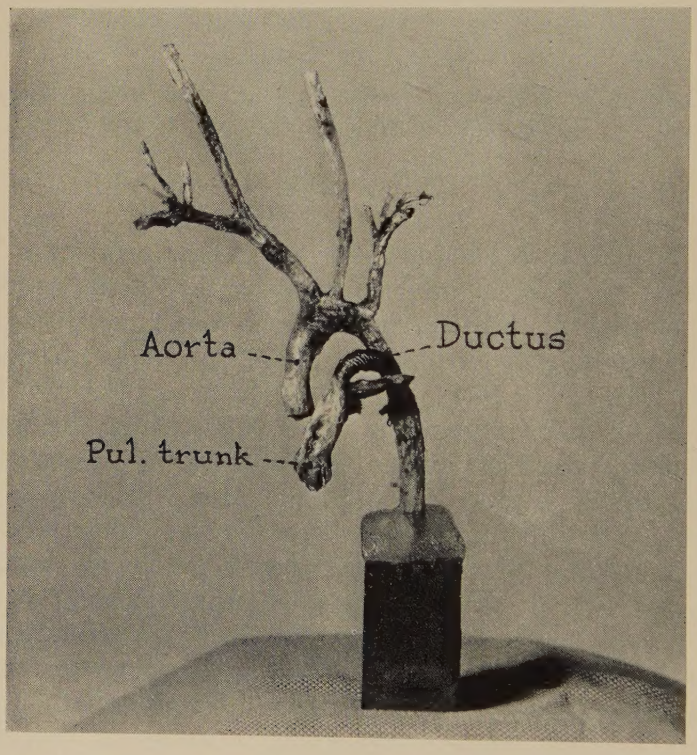

Fig. 1 Vinyl acetate cast of major thoracic vessels with ductus arteriosus shaded.

Accordingly, the plan followed was to remove the infant's sternum and reflect the thymus gland from the pericardium. Then a solution of vinyl acetate, a plastic which hardens on contact with moisture, was separately injected by means of needle and syringe into each cardiac ventricle so as to fill out the major vessels. Moderate manual pressure was used dur-

ing the injection in order to fill out the vessels to their apparent caliber. Twenty-four hours later when the vinyl acetate had hardened into a rigid cast, the latter was dissected out in situ and mounted on a wax bock and photographed (figs. 1 and 2). Several views were taken of the angle and the largest measurable angle was taken to be the most accurate.

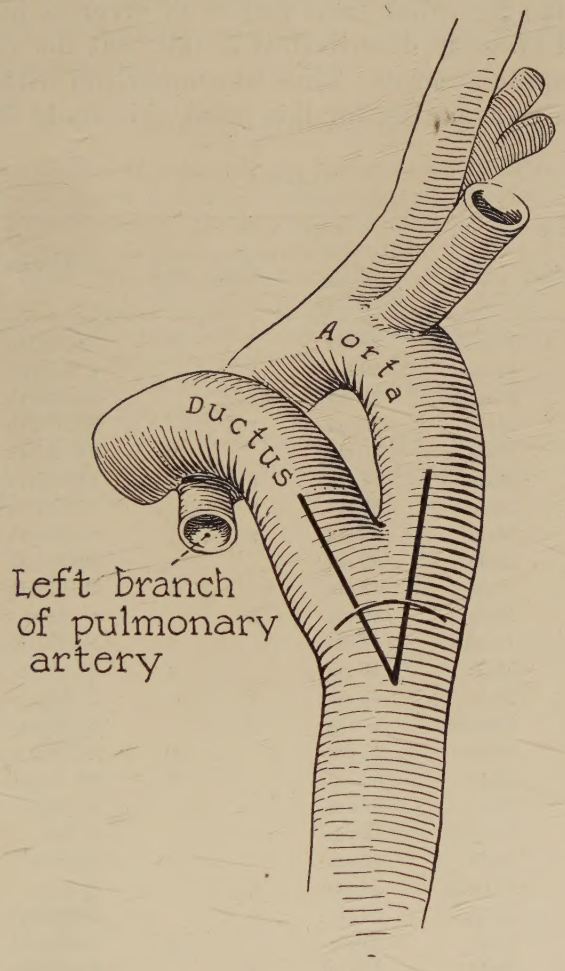

Fig. 2 Anatomical sketch of angle formed by Ductus Arteriosus with descending thoracic aorta.

Table 1 summarizes the finding obtained in this study. The average angle in the 24 cases is 31.8°. In the 9 infants that had lived a varying period of time the average is 32.1° as compared to an average angle of 31.6° in the 15 stillbirth infants. In the 10 full-term infants the average angle is 31° as compared with an angle of 32.4° for the 14 premature infants. In no instance was an angle greater than 37.5° or less than 25° obtained.

Despite the fact, that some degree of error is inherent in the method of study described, it is felt that the results obtained are quite accurate. Thus in comparison with the only two references available, for this point, this study finds itself

TABLE 1

NO.	PROTOCOL NUMBER	SEX	LENGTH OF INFANT	PRE-MATURE	FULL-TERM	LONGEVITY	ANGLE FORMED BY DUCTUS WITH DESCENDING AORTA
1	A1766	Female	48 cm		x	Stillbirth	25 degrees
2	6758	Male	39 cm	x		5 hours	28 degrees
3	A1769	Female	30 cm	x		Stillbirth	34 degrees
4	6777	Male	39 cm	x		Stillbirth	30.5 degrees
5	6784	Male	55 cm		x	Stillbirth	35 degrees
6	6791	Male	33 cm	x		Stillbirth	37 degrees
7	6799	Male	30 cm	x		Stillbirth	33.5 degrees
8	6816	Male	33 cm	x		Stillbirth	30 degrees
9	6817	Male	48 cm		x	Stillbirth	37.5 degrees
10	6881	Male	47 cm		x	Stillbirth	30 degrees
11	6882	Male	40 cm	x		5 days	30 degrees
12	A1838	Female	40 cm		x	Stillbirth	30 degrees
13	6891	Male	46 cm		x	15 days	34 degrees
14	6903	Male	40 cm	x		2 days	37 degrees
15	6904	Female	35 cm	x		Stillbirth	30.5 degrees
16	6905	Male	45 cm		x	Stillbirth	28 degrees
17	6907	Male	56 cm		x	22 hours	32 degrees
18	6919	Male	33 cm	x		2 days	36 degrees
19	6920	Female	30 cm	x		1 day	31.5 degrees
20	6923	Male	53 cm		x	3 days	27 degrees
21	6928	Female	34 cm	x		2 days	34 degrees
22	A1853	Female	34 cm	x		Stillbirth	32 degrees
23	6968	Male	51 cm		x	Stillbirth	32 degrees
24	6983	Male	32 cm	x		Stillbirth	30 degrees

in close agreement with Roux and at variance with the description given by Faber ('12).

The author wishes to acknowledge sincere gratitude to Dr. Kornel L. Terplan for making this study possible and to Mr. Ivar Cederholm for his meticulous photographic work in connection with this study, and to Mr. Melford Diedrick for the medical illustrations.

LITERATURE CITED

FABER, A. 1912 Die anatomischen und physicalischen Verhältnisse des Ductus Botalli. Arch. f. Anat. u. Entwcklngsgesch., 157–170.

FROMBERG, C. 1914 Studien über den Ductus Arteriosus. Arb. a. d. Geb. d. path. Anat., Inst. zu Tubing., *9:* 198–224.

SCHANZ, F. 1889 Über den mechanischen Verschluss des Ductus Arteriosus. Arch. f. d. ges. Physiol., Bonn 1888–1889, *44:* 239–269.

STRASSMANN, P. 1893 Ueber den Mechanismus des Verschlusses des Ductus Arteriousus (Botalli). Arch. f. Physiol., 566.

———— 1902 Der Verschluss des Ductus Arteriosus (Botalli). Beitr. Geburtsh. Gyn., *6:* 98–177.

WALKHOFF, F. 1869 Quoted from Klotz, O. 1907. The closure of the Ductus Arteriosus and its bearing on Arteriosclerosis. Assn. Am. Physicians, *32:* 213–228.

BOOK REVIEW

ON THE EXPERIMENTAL MORPHOLOGY OF THE ADRENAL CORTEX. By Hans Selye and Helen Stone. 1950. vii + 105 pages, 62 figures. $2.25. Charles C. Thomas, Springfield, Illinois.

Best known for his work on the adaptation syndrome and diseases of adaptation which was presented in 1946, Doctor Selye is at present Professor and Director of the Institute of Experimental Medicine and Surgery at the University of Montreal. Helen Stone is associated with the same Institute.

This monograph of the American Lecture Series is devoted to the description of morphological alterations of the adrenal cortex elicited by various combinations of anterior pituitary preparations, thyroxine, testoids and corticoids. The study was instituted to establish morphologic criteria, which would permit the appraisal of adrenocortical function and, in addition, to supply further information regarding the existence or non-existence of several qualitatively different corticotrophic agents.

The first portion of the study describes 6 experiments, utilizing adult Wistar Albino rats, in which the following results were noted. Lyophilized anterior pituitary tissue (LAP) causes an increase in adrenal weight which is enhanced by an increase of ingested protein. Methyl testosterone causes a decrease in adrenal weight which is not influenced by a high protein diet and it inhibits the adrenal enlargement normally caused by thyroxine or non-specific stress. It does not prevent the enlargement of the gland caused by LAP, however. Thyroxine causes moderate enlargement and when combined with LAP, it increases the corticotrophic effect of the latter. Unilateral nephrectomy and high sodium intake were unimportant with regard to their effect on adrenal weight changes induced by LAP, thyroxine or methyl testosterone. There were no important differences in the response of either male, castrate male or female animals to the various compounds or combinations of compounds used. Desoxycorticosterone acetate does not inhibit adrenal enlargement resulting from anterior pituitary extract nor does it cause "compensatory atrophy" of the adrenal with high sodium intake.

The second half of the monograph is devoted to observations of the typical structural changes that can be experimentally produced in

the adrenal cortex. This part of the study endeavors to demonstrate that, in addition to the non-specific morphological alterations due to simple stimuli, the adrenal cortex can respond to specific stimuli with more precise morphological alteration. According to the authors this characteristic of the adrenal cortex speaks against the theory of a single corticotrophic agent but should this be the case, the simultaneous presence of other hormones might explain the variability in the morphology.

On the basis of histological and cytological examination of the adrenal cortical tissues of the animals used in the experiments referred to above and, in addition, experience gained from experimentation during the last 10 years, the following qualitatively different morphologic changes were distinguished by the authors: atrophy, hypertrophy, hyperplasia, capsular adenoma, lipid granule storage or discharge, cholestrol granule storage or discharge, plasmal granule storage or discharge, ascorbic acid granule storage or discharge, fatty metaplasia, colloid formation, fibrinoid degeneration, cytolysis, "chromidiosis," lymphoid and myeloid metaplasia, formation of lumina within the cortical parenchyme, holocrine secretion, hyperemia, hemorrhagic infraction, focal necrosis and "toxic involution."

The printing, paper, binding, and general plan of the book are good but, contrary to the authors' expressed opinion that the material was too diverse and too voluminous, it might have been more advisable to present the findings as articles in a related periodical. The meaning of the text is sometimes obscure and difficult to follow. It also seems that some of the analyses of the morphologic alterations should have been reserved until more complete investigations are reported. Despite the fact that there are notations made to related papers throughout the monograph and a list of references at its end, research into the literature is lacking. Articles by several prominent investigators were evidently not consulted. A study of this sort which attempts to establish the relationship between morphological alteration and functional state of the gland might embody a more representative review of the literature.

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Louisiana State University
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BOOK REVIEW

HUMAN FERTILITY AND PROBLEMS OF THE MALE. By Edmond J. Farris. 1950. xvi + 211 pages, illustrated. $5.00. The Author's Press, Inc., Palisades Park, New Jersey.

The author is widely known as the Executive Director of The Wistar Institute of Anatomy and Biology. He has been actively engaged in research problems dealing with or allied to fertility for at least 10 years and has contributed many scientific publications in this field. Some of this work has been experimental, on animals, and some has been clinical, with patients. The members of the Anatomists' Association at their annual meetings have been enlightened and entertained by his cinematographs of spermatozoa. It has been interesting to watch Doctor Farris's concern with this subject expand from scientific curiosity into a humanitarian desire to help people with sterility problems, as he has become more and more successful in finding the answers to his questions.

The author has undertaken, to use his own words, a difficult assignment in preparing a book which is applicable and informative both to the medical profession and to intelligent and interested laymen. It is his belief that scientifically minded laymen have a right to learn and evaluate the material which has been gathered and that it is in accord with recent efforts of the medical profession to acquaint the public with its problems.

The introductory portion of the book is designed to give the layman a technical background which he will need in order to follow the scientific material presented later. The humanitarian importance is powerfully emphasized. In the next few chapters the methods of studying the individual are outlined. The personal history form, method of collecting specimens, of examining them and counting motile spermatozoa are given in detail sufficient to guide the laboratory worker or practicing physician.

In chapter 7 the data obtained from 239 individuals is used to bring out a relatively simple index of fertility. The evidence points to the absolute motility, i.e., the total number of active spermatozoa, as the significant observation. Individuals are placed in three classes: (1) High fertility, with 185 million or more absolute motility, (2) Relative fertility, 80 to 185 million and (3) Subfertility, less than

80 million. Observations on the various different factors influencing the sperm and the absolute motility of specimens from these three classes are presented in the next 5 chapters and the information thus obtained is used in chapter 13 to show how fertility can be improved.

The remainder of the book is concerned with artificial insemination and methods of giving assistance to sterile and barren couples. The author's success in giving advice in these fields is due in large part to the rat test for ovulation which he devised and published earlier.

The simple, matter-of-fact attitude which Doctor Farris has adopted and rather skillfully maintained during the description and discussion of some delicate and intimately personal matters should make the book valuable to genuinely interested laymen. Some parts should provide essential instructions to laboratory technicians or physicians dealing with these problems and some of the data presented make a genuine scientific contribution.

C. M. G.

AMERICAN SOCIETY OF ZOOLOGISTS

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Notice

For a list of the names of the former officers of the Society, including representatives of the Division of Biology and Agriculture of the National Research Council, the associate editors of the Journal of Morphology and the constitution of the Society, see The Anatomical Record, Vol. 103, No. 2, 1949.

PROCEEDINGS OF THE FORTY-SEVENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF ZOOLOGISTS

HOTEL HOLLENDEN AND WESTERN RESERVE UNIVERSITY

CLEVELAND, OHIO

DECEMBER 27, 28, 29, 30, 1950

PROGRAM

The Annual Meeting of the American Society of Zoologists was held in Cleveland, Ohio, in conjunction with Section F of the American Association for the Advancement of Science, and in conjunction with other biological societies. The meetings for the reading of most papers were held in Hotel Hollenden. The demonstration program and one session for the reading of papers were held in the Biology Building of Western Reserve University. The movie program was presented in the auditorium of the Cleveland Academy of Medicine.

The Cleveland meeting was well attended but the attendance was about one-third less than in New York City a year ago. The total number of papers on the program scheduled to be read in person was 142, of which 16 were presented by demonstration. There were 108 papers included in the program as "read by title."

The Biologists Smoker was held on Friday evening, December 29, in the South Exhibition Hall of the Cleveland Auditorium.

The Annual Dinner of the American Society of Zoologists was held on Friday evening, December 29, in the Assembly Room of Hotel Hollenden, with 125 persons attending. An address on "Sex Differentiation: Genes or Hormones" was presented by Dr. Lincoln V. Domm, Vice-President of the

American Association for the Advancement of Science and Chairman of Section F.

BUSINESS MEETING

The forty-seventh annual business meeting opened at 4:40 P.M. on Wednesday, December 27, President Alfred S. Romer presiding.

The following business was transacted:

1. The minutes of the last meeting. These were published in the March 1950 supplement of The Anatomical Record and distributed to all members of the Society. It was voted to approve the minutes as printed.

2. Memorial resolutions. The Secretary reported that during the year the Society had suffered the loss by death of 7 Active and 1 Associate members: Rudolph Bennitt, Mychyle W. Johnson, John W. MacArthur, Vasil Obreskove, Charles G. Rogers, Morris Steggerda, J. Paul Visscher, and Edward M. Walzl. The following resolutions were prepared:

RUDOLF BENNITT

1898–1950

Rudolf Bennitt, professor of zoology and chairman of the Missouri Wildlife Unit, died unexpectedly from a heart ailment on February 2, 1950. He was born in Springfield, Massachusetts, December 22, 1898, educated in the schools of that city, at Boston University (B.S., 1920; A.M., 1921), and at Harvard (A.M. and Ph.D., 1923). At Harvard, he was an Austin Teaching Fellow (1920–22) and worked under the direction of Professor George H. Parker. After service as assistant professor of zoology at De Pauw University (1923–24), and as an instructor at Tufts College (1924–1927), he became associate professor of zoology at the University of Missouri in 1927, was advanced to a full professorship in 1937, and became William Rucker Professor of Zoology in 1944. Before coming to the University of Missouri he had served as "one of George M. Gray's boys" in the Supply Department and later as a member of the Invertebrate staff of the Marine Biological Laboratory. Thus, he came to Missouri with the broad foundation for the teaching and research which he conducted in this institution.

During his earlier years in Missouri, Dr. Bennitt's interests were in continuation of his studies upon the physiology of vision in crustaceans which he had begun as a graduate student. Other teaching interests led him into ecological fields, notably bird study, and he proceeded in this direction as the work developed which culminated in the establishment of The Wildlife Research Unit in 1937. Although not a

naturalist from childhood, which gives a foundation for which there is no substitute, he had a breadth of training such as few men of his generation of conservationists could boast. Upon this foundation he became an effective investigator in the out-of-doors. During these transitional years (1931–1937) he published various papers in the field of ecology and conservation, such as his check-list of the birds of Missouri and his survey (with W. O. Nagel) of the resident game and fur bearers of the state, and began the studies upon quail which became his principal field of research until his death. His complete bibliography is appended to the obituary by Robert S. Campbell (Jour., Wildlife Management, Vol. 14, no. 3, July, 1950).

When the Missouri Wildlife Research Unit was organized in 1937, Dr. Bennitt became its guiding spirit and he was able to develop what was virtually a department of his own although nominally within the department of zoology. Under his leadership it became one of the outstanding units in this rapidly developing field of biology. His reputation became national, and was recognized by his election as the first president of the Wildlife Society. His other biological affiliations were with the A.A.A. Association, American Society of Zoologists, Ecological Society, Society of Mammalogists, Ornithological Union, and the Wilson Ornithological Club.

The appointment of Rudolf Bennitt is regarded by those acquainted with the circumstances as one of the most satisfactory ever made within the department of zoology at the University of Missouri. Dr. Bennitt more than lived up to expectations on the personal side and his professional record speaks for itself. He was an excellent and a conscientious teacher, and always more than willing to do his share of departmental work. As chairman of the department until 1939, the writer found it necessary to protect him against his willingness and his unselfishness, although in many instances I was unable to devise or to implement such protection. There was a guileless honesty about him that made the task well-nigh impossible. Of such is the Kingdom of Heaven. His wife, Ruth Eynon Bennitt, and his two daughters, have indeed a proud memory of him as a man and as a scientist. The bronze plaque erected in our Wildlife Conservation Biulding by the Conservation Federation of Missouri well summarizes his personal and professional life:

> "First Chairman of the Missouri Wildlife Research Unit 1937–1950. Scholar, teacher, and conservationist. His industry and unselfishness were largely responsible for the initial reputation of this unit."

Winterton C. Curtis

MYCHYLE WELLINGTON JOHNSON

1910–1950

Dr. Johnson was born at Mount Horeb, Wisconsin, September 11, 1910. He died in his office at Duke University, September 25, 1950. He worked his way through Indiana Central College and received his A.B. degree in 1930. He served as assistant at Indiana University 1930–1935 and attained his Ph.D. in the field of cytology in 1935.

Dr. Johnson married Mary Moore in 1935 and accepted a position in the Carnegie Institution of Genetics at Cold Spring Harbor, N. Y. There he worked in the field of endocrinology until 1937. Then he went to the Zoology Department at Duke University, where he taught embryology, comparative anatomy, and genetics. He also served as Advisor for Premedical Students and Secretary of Sigma Xi. He was one of the founders of the local bird club, took boys on bird observation trips and was also one of the founders of the local children's museum. He played in the Duke University and North Carolina Symphony Orchestras.

Dr. Johnson published papers on the nuclear characteristics of arthropods, gonad-stimulating hormones, sex reversal in dove hybrids, methods of trapping, photographing, mounting specimens, and micromanipulating. Two of his papers were in press when he died.

Dr. Johnson did everything cheerfully, thoroughly, and well. His students and colleagues respected and loved him. His death is regretted by all who knew him.

A. S. Pearse

JOHN WOOD MacARTHUR

1889–1950

John Wood MacArthur was born in Buffalo, N. Y., on September 2, 1889. After taking his A.B. at Oberlin and his A.M. at Wabash he went on to Chicago from where he received his Ph.D. in 1921. While there he met and married Olive Turner a fellow student who became his life-long confidant in things genetic as well as domestic and collaborated with him in papers on human genetics and in the raising of their four children: Helen, John, Jean and Robert.

His first teaching appointments were in the field of comparative anatomy but he soon shifted to experimental Biology and taught this at Toronto from 1919 to 1923. By this time his interest in the newer science of Genetics had become all-absorbing and he was appointed to a joint professor of Genetics at the University of Toronto and the Ontario Agricultural College. He held this appointment until 1935 at which time he became a full-time member of the University staff. Through his agricultural connections he became interested in the genetics of the fowl and of the tomato. He discovered and published on several sex-linked genes in fowl. In the tomato he was one of the early workers in the field of chromosome mapping and before his death had become the leading authority on linkage relations in this species being responsible for the mapping of 27 of the 34 know loci. Along with his work on chromosome mapping he became interested in the inheritance of fruit size and his paper on geometric size inheritance attracted wide attention. In the search for further proof of his theory of size inheritance he turned to dogs and mice. Beginning with a mixed stock of mice he was able by means of mass progeny selection to more than double the weight in the large strain and at the same time to select a small strain only half the body weight of the original strain. This selection was carried out over 30 generations and the stocks so developed are being widely used for further research.

By 1935 he had become interested in multiple births in humans and developed a system for analyzing dermatoglyphics so that they could be used for twin diagnosis. At about the same time he began his study of the Dionne quintuplets, which as well as attracting a great deal of publicity also proved that the quints were monozygotic.

Before J. W. MacArthur died on July 4, 1950, he had published 34 articles, eleven of which were on the genetics of the tomato, seven on human genetics and four on mice. At the last scientific meetings which he attended it was easy to observe that reasearch workers in these fields looked to him for guidance and advice. He with characteristic generosity gave of his time and advice freely and stimulated many a researcher to put forth greater effort. His vast knowledge and great memory for the literature made him a valuable consultant.

In 1948, partly because of his increasing deafness and partly because of his preference for small classes, he left Toronto and went to Marlborough College to organize their Biology Department. In this new assignment he soon endeared himself to all the students and was appointed dean. Their new Biological Laboratory has been named in memory of him.

L. Butler

VASIL OBRESHKOVE

1890–1950

Vasil Obreshkove, who died suddenly on July 14, was Professor of Biology and the senior member of the Bard College Faculty. In June he had completed 25 years of teaching at Bard. Students and faculty in celebration of the occasion had presented him at the conclusion of the Baccalaureate Service with a special gift as an expression of their affection and respect.

He came to the United States from Bulgaria in 1905 and was naturalized in 1918. A graduate of Genesee Wesleyan Seminary, he received his B.S. and M.S. degrees at Syracuse University. In 1920 he received his Ph.D. at Harvard University where he had held the Thayer Fellowship in Physiology.

Before coming to Bard in 1926 (then St. Stephens) he had taught at Syracuse University where he had been successively instructor, assistant professor and associate professor of Zoology.

During the first World War, Dr. Obreshkove served as a second lieutenant with the United States Army Medical Corps. He was a member of the American Association for the Advancement of Science, The American Society of Zoologists, The Society of Experimental Biology and Medicine, Sigma Xi, and the Phi Beta Kappa.

He was a frequent contributor to the Journal of Experimental Zoology, Journal of Morphology and Physiology, Physiological Zoology, and the Journal of Cellular and Comparative Physiology.

He is survived by Mrs. Obreshkove, who is now living at 116 McAllister Avenue, Syracuse 5, N. Y.

Editor,
Bard College News Letter

CHARLES GARDNER ROGERS

1875–1950

Charles Gardner Rogers was born in 1875 at Perry, N. Y., and passed away in Oberlin, Ohio, October 12th, 1950. He is survived by his wife and by a married son and daughter.

Professor Rogers was a graduate of Syracuse University with both the A.B. and the M.A. degrees, and in 1920 he received the honorary D.Sc. from the same institution. Meantime he had earned his Ph.D. under Jacques Loeb at the University of California. He taught for a short time at the University of Kansas and at Syracuse, and in 1913 was called to a professorship of zoology in Oberlin College where he remained for the rest of his life. During the years 1924–1926 he was acting Dean of the College, and upon retirement of Professor Budington he took over the headship of the Zoology Department.

Though he was active in various courses at Oberlin his primary interest was always physiological, and during his later years he gave his entire time to this subject. His chief research was along the lines of comparative physiology, and comprised investigations of effects of saline solutions on the heart; the physiology of nerve cells; fat digestion and absorption in the lower animals, and heat production during various physiological processes. He was also the author of an outstanding text in comparative physiology which contained considerable material resulting from his own investigations. Aside from his work at Oberlin, Dr. Rogers always spent his summers at Woods Hole, where he was a familiar figure. He taught for some years in the embryology course there, and pursued his various research projects.

In addition to his membership in this society he belonged to the Society of Naturalists, the Physiological Society, the American Geographical Society, the Ohio Academy of Science and of course the A.A.A.S. He was also a member of Phi Beta Kappa and of Sigma Xi.

Robert S. McEwen

MORRIS STEGGERDA

1900–1950

Dr. Morris Steggerda had been Professor of Anthropology at the Hartford Seminary Foundation (Kennedy School of Missions) for a little less than 6 years when a recurring heart attack took him away.

He was born in Holland, Michigan, of Dutch-American descent; obtained his A.B. there, from Hope College (1922); his M.A. and Ph.D. from the University of Illinois, in the Department of Zoology, (1923, 1928). In the latter year he was appointed Assistant Professor of Zoology at Smith College (Northampton, Mass.). The same year he married Inez Dunkelberger, an Instructor in the depart-

ment. In 1932 their son Charles was born. Dr. Steggerda became an Investigator with the Department of Genetics, Carnegie Institution of Washington at Cold Spring Harbor, N. Y. in 1930; there he remained for 14 years, surrendering this post, in 1944, to accept the Professorship of Anthropology at Hartford Seminary Foundation (Connecticut).

Before obtaining his Ph.D., he had come under the notice of Charles Davenport. With the latter, he sailed (in 1926) to the British West Indies to investigate the physical and mental traits of the native population. The Inhabitants are a composite of whites, blacks and hybrids, living under practically identical conditions, and presumably unvexed by anything like the "caste" system of the United States; apparently, therefore, they offered optimum conditions for exploring genetically-determined racial differences. The result of this excursion was Steggerda's Ph.D. thesis, and joint authorship, with Davenport, of the study, *Race Crossing in Jamaica* (1929).

In 1930, when the American Association of Physical Anthropologists was founded, Dr. Steggerda was elected to membership. From that year on, by virtue of his position with the Carnegie Institution, he became most particularly identified professionally as an anthropometrist. Ten seasons he spent measuring Maya Indians in Yucatan; he made several excursions among the Navajo; he measured the students of Tuskeegee Institute, and the population of his native town. From 1943 to 1946 he was on the Executive Committee of the American Association of Physical Anthropologists; from 1946 to 1948 he was its Vice President.

Beside this professional identification, he was a member of Sigma Xi; the American Association for the Advancement of Science; American Association of Naturalists; Eugenics Research Association; Eugenics Society (hon. memb.); American Anthropological Association (Council memb.); American Zoological Society.

Dr. Steggerda's focus of research was human variation and growth. He undoubtedly was one of the most painstaking and prolific measurers of living man — from infant to adult, male and female, Indian, Negro, White — that American science has produced. His publications (over 240 titles, from notes to books, ranging from the scientific to the religiously devotional) have made much of this available; other masses remain in his files, unpublished.

But Morris Steggerda — this can be said quite certainly — valued his research labors far below the human touch — of Indian, of Negro, of White. His last years saw no abundance of new research, either pursued or published; but they were amazingly rich in contacts with students; with men and women still fresh from academic life, and with others returning from years of active living to complete their studies for a higher degree. In the presence of any person whose life held experiences that he could never have, Morris Steggerda was gently humble, even qaintly so; he believed that, no matter how much he gave to a person he always received more. Dedicated to the things of science, he nevertheless was first and last a great humanitarian. If a choice were necessary, the latter status he undoubtedly would prefer to be his monument.

Earl W. Count

JOHN PAUL VISSCHER

1895–1950

John Paul Visscher, Professor of Biology at Western Reserve University, died suddenly on February 11, 1950. In his death invertebrate zoology generally and Ohio biology lost an able and stimulating leader.

He was born in Holland, Michigan, September 19, 1895, and graduated from Hope College, Michigan, with the Bachelor of Arts degree in 1917. After duty with the Chemical Warfare Service in 1917–18, he continued his biological studies at the Johns Hopkins University where he received a Master's degree in 1920. After spending two years as instructor in Zoology, Washington University, he returned to Johns Hopkins in 1922 as a Bruce Fellow and received his Doctor of Philosophy degree in 1924.

In the autumn of the same year, he joined the Biology Department, Western Reserve University, and was Chairman of the department from 1937 to 1945. Professor Visscher took a prominent part in the natural history, religious and professional life of the community. He served as a trustee of the Cleveland Museum of Natural History and the Garden Center of Greater Cleveland, and as President of the Cleveland Bird Club; the Wild Flower Club of Cleveland, as well as the Professional Men's Club of Cleveland. For several years he was Associate Editor of Bird Life magazine.

His study of barnacles begun at Hopkins and continued at the Marine Biological Laboratory, Woods Hole, Massachusetts, at Naples, Italy, at the Plymouth Laboratory, England, the Dry Tortugas Laboratory, Florida, and at the Pearl Harbor Naval Station culminated in a series of papers on the physiology, behavior and life cycle of the Cirripedia.

Professor Visscher was a member of the American Society of Naturalists, American Society of Zoologists, Fellow of the American Association for the Advancement of Science; Fellow, Ohio Academy of Science; Sigma Xi and Phi Beta Kappa.

LEONARD B. CLARK

EDWARD McCOLGAN WALZL

1910–1950

Biological science and clinical medicine both sustained a real loss when Edward McColgan Walzl died, August 10, 1950, at the age of only forty years. The contributions Dr. Walzl made to both of his major fields of work exemplify the best possibilities obtainable from a prolonged training like that which he chose. His investigations were well conceived and executed; his clinical work was excellent. Humanity is the real loser when such men die young.

Edward M. Walzl was born January 22, 1910, in De Beque, Colorado; his parents were John Henry and Mary Catherine McColgan Walzl. At the age of eleven years an attack of poliomyelitis left young Walzl with many permanently atrophic and weakened muscles, but fortunately spared his intellect. He trained himself to use the non-paralyzed muscles so skillfully that everyone who ever watched him work, either in a laboratory or in a surgical operating room, marvelled. Walzl attended Mount St. Mary's College for two years; the rest of his formal

education was at Johns Hopkins University, which granted him the degree of A.M. in 1934, of Ph.D. (Zoology) in 1935, and of M.D. in 1942. His graduate studies under the late Dr. S. O. Mast, then Professor of Zoology at Hopkins, were mainly on the actions of electrolytes on the heart beat of the oyster, a topic which naturally led to an interest in allied problems of clinical medicine.

His doctoral work completed, Walzl stayed in Mast's department for a short time, then secured an assistantship in the department of pharmacology in the medical school. From 1937 until the time of his death, Dr. Walzl was a member, in one capacity or another, of the staff of the sub-department of Laryngology and Otology of the Johns Hopkins University School of Medicine, rising to the rank of Associate Professor. During the early years of this period of his life, Walzl combined experimental studies in the Otological Research Laboratory with the routine work of a medical student; he continued to make basic studies on the physiology of hearing during the "War Years" when he was, successively, Intern, Assistant Resident and Resident in Laryngology and Otology at the Johns Hopkins Hospital and had an especially heavy load of clinical duties because of the shortage of house staff incident to military needs. It is an interesting commentary of utilization of the nation's manpower to note that Dr. Walzl, who could not begin to satisfy the physical standards set for military service, nevertheless, could do clinical and laboratory work 18 hours a day, 30 days a month, and come up smiling and alert.

In recent years, Dr. Walzl carried on an active clinical practice in the specialty of otolaryngology and continued his laboratory studies on neurophysiological problems related to the ear, particularly with respect to tonal localization in the cochlea and in the cerebral cortex, and to the cerebellar and other central connections of the vestibular part of the ear. When incapacitated by myasthenia gravis nearly ten months before his death, Walzl had other investigations under way that utilized his combined background of scientific training and clinical experience. The premature death of Ed Walzl is a bereavement not only to his wife, the former Florence L. Lichtfield, whom he married in 1940 and who survives him, but also to all who are concerned with the advancement of knowledge in the fields of biology and medicine.

STACY R. GUILD

The foregoing resolutions were adopted and the Secretary was instructed to send copies to the nearest relatives and to publish the resolutions in the Proceedings of the Society.

3. Report of the Treasurer. The Treasurer, Frank A. Brown, Jr. presented the following report for the year 1950:

Credits:

Cash balance from 1949	$2,821.38	
Receipts from dues during 1950	5,182.50	
Aid to Foreign Scientists	20.00	
		$8,023.88

Debits:				
Secretary's Expenses:				
Traveling stipend	$200.00			
Clerical and miscellaneous	676.91			
		$ 876.91		
Treasurer's Expenses:				
Postage	54.00			
Clerical	180.00			
Miscellaneous	32.50			
		266.50		
Wistar Institute Expenses		1,407.86		
Biological Abstracts subscriptions		1,812.00		
Aid to Foreign Scientists		20.00		
Purchase 1 U. S. Savings Bond		740.00		
Bank charges		23.33		
			$5,146.60	
Balance, December 19, 1950				
Checking account		2,877.28		
			$2,877.28	
				$8,023.88

4. Report of the Auditing Committee: The Auditing Committee consisting of H. H. Strandskov and O. Rulon presented the following report:

We, the undersigned, have this day audited the report of the Treasurer of the American Society of Zoologists and find the report correct as stated.

Signed: Herluf H. Strandskov
Olin Rulon

It was voted to accept and approve the above reports of the Treasurer and of the Auditing Committee.

5. Report of the Executive Committee.

(a) Aid to Foreign Scientists. Dr. Plough reported that during 1950 his committee had collected only $20.00 for this purpose and asked that the committee be discharged.

Approval was given by the Society.

(b) Financial Support of Biological Abstracts. The Committee recommended that $1.00 from each membership fee of $5.00 be paid to Biological Abstracts.

The Society voted approval of this recommendation.

(c) Election of New Members. In accordance with the stipulations in the constitution regarding membership, the Committee recommended the following candidates for election to membership in the Society:

NEW ACTIVE MEMBERS

(Formerly Associate Members)

Anderson, John Maxwell
Black, Edgar Clark
Blivaiss, Ben Benton
Bryson, Vernon
Dent, James Norman
Foote, Florence Martindale
Frey, David Grover
Fry, Frederick Ernest Joseph
Ginsburg, Benson Earl
Miller, David F.
Moment, Gairdner Bostwick
Pitelka, Frank Alois
Russell, Elizabeth
Talmage, Roy VanNeste
TeWinkel, Lois Evelyn
Thornton, Charles Stead
Trinkaus, John Philip

(Not Formerly Associate Members)

Brunst, Victor V.
Crow, James Franklin
Edgar, Samuel Allen
Finkel, Miriam Posner
Fulton, George Pearman
Hilleman, Howard Herbert
Leuchtenberger, Cecilie
Ross, Sherman
Sonnenblick, Benjamin Paul
Van Weel, Pieter Boudewijn
Wasserman, Friederich

NEW ASSOCIATE MEMBERS

Baker, Alice Schwarze
Bardach, John Eugene
Barnhardt, Marion Isabel
Bovee, Eugene Cleveland
Bridgman, Anna Josephine
Brown, Walter Creighton
Bryden, Robert Richmond
Copenhaver, John Harrison, Jr.
Daniels, Edward William
Fales, Catherine Harris
Ferguson, Edward, Jr.
Goldstein, Lewis Charles
Hartman, Willard Daniel
Hellbaum, Halcyon Woodward
Higgenbotham, Arlyn Curtis
Kaltenbach, Jane Couffer
Lehman, Harvey Eugene
Lessler, Milton A.
Levi, Herbert Walter
Lovelace, Lollie Roberta
Merklin, Robert Joseph
Newcomer, Wilbur Stanley
Opton, Edward Milton
Passonneau, Janet Vivian
Rennels, Edward Gerald
Ringle, Stata E. (Norton)
Roberts, Henry Stoutte, Jr.
Sandeen, Muriel Jone
Sangster, William
Sawyer, Wilbur Henderson
Sullivan, Bernard J.
Talbert, George Brayton
Ulmer, Martin John
Walker, Warren Franklin
Webb, H. Marguerite
White, Marcia R.
Young, Frank Nelson, Jr.
Young, Howard Frederick

It was voted that all candidates be elected as recommended by the Executive Committee, and the Secretary was instructed to cast one ballot in their favor.

Changes in membership. For the information of the Society the Secretary reports the following changes in the membership which occurred during the past year. The summary given below includes the above elected candidates.

Deaths	8	New Associate Members	38
Resignations	8	Reinstated	0
Dropped	5	New Active Members	28
Total enrollment at present			1220

Election of Officers. The Nominating Committee consisting of Harold Kirby, Chairman; Ross F. Nigrelli, and Harold R. Wolfe, presented the following report:

1. President, 1 year: Douglas M. Whitaker.
2. Vice-President, 1 year: Lincoln V. Domm.
3. Treasurer, 3 years: Harry A. Charipper.
4. Executive Committeeman, 5 years: Alfred S. Romer.
5. Society Representative on the Council of the American Association for the Advancement of Science, 2 years: Robert C. Miller.
6. Society Representative on the Advisory Editorial Board of Biological Abstracts, 4 years: Karl P. Schmidt.
7. Society Representative on the Executive Committee of the Biological Stain Commission, 1 year: F. H. J. Figge.
8. Society Representative on the Board of Trustees of The American Type Culture Collection, 1 year: D. H. Wenrich.
9. Society Representatives on The Motion Picture Committee, 1 year: Ralph Buchsbaum, Chairman; William R. Duryee, Edmond J. Farris, L. J. Milne, Oscar Richards, and John P. Scott.
10. Members of the Editorial Board of the Journal of Morphology, 3 years: Florence E. Moog, John A. Moore, Leonard I. Worley.

It was voted that the above named candidates for office be elected and the Secretary was instructed to cast one ballot in their favor.

Committee Reports. (a) The following report was prepared by Dr. Frank H. J. Figge, Representative of the Society

on the Executive Committee of the Biological Stain Commission:

The annual meeting of the Biological Stain Commission was held at the University of Pennsylvania School of Medicine, March 24, 1950. Dr. Kornhauser and Dr. Windle were reelected trustees-at-large for one year. Dr. Lillie's report for the Committee on Mounting Media indicated that various ester gums of the varnish trade offered encouraging possibilities. Dr. Davenport reported for the Committee on Rules of acceptance for stains for certification that a new set of rules for acceptance of stains for certification had been prepared. These were adopted by the Commission. The reports of the Treasurer and Finance Committee and other committees were read, considered and approved.

The Commission is not only self-supporting, but is able to support a small number of research projects, in which the Commission is interested. This support takes the form of small grants to investigators who are interested in the fundamental aspects of staining techniques. The grants to Dr. J. W. Bartholomew, Dr. H. A. Davenport, Dr. C. P. Le Blond, and Dr. E. Stotz have been renewed. The reports on the work being done by these investigators with this assistance appear from time to time in "Stain Technology."

The plans for holding a symposium on Histochemistry in connection with the meeting of the Biological Stain Commission blossomed and bore fruit. The response to the request for papers for this meeting was almost overwhelming. Sixty abstracts of papers were submitted; thirty-two selected for presentation. This first meeting proved to be a very good one. The attempt to bring together investigators from such various disciplines as Pathology, Anatomy, Endocrinology, Bio-Chemistry, Zoology, Botany, and Bacteriology was so successful that plans for the formation of a Histo-Chemical Society are underway. We shall all look forward to the next meeting of this Society and hope that it continues to display the hybrid vigor of the first meeting. Dr. R. D. Lillie and his group at the National Institute of Health deserve a great deal of praise for their organization and management of the first program meeting.

(b) The Motion Picture Committee, consisting of Dr. Ralph Buchsbaum (Chairman), Dr. William R. Duryee, Dr. Edmond J. Farris, Dr. Lorus J. Milne, Dr. Oscar Richards, and Dr. John P. Scott present the following report of activities for the year 1950: (1) A program of films was assembled for the annual meeting of the society and presented on Thursday, December 28, 1950, at Cleveland, Ohio; 50 persons were present. The response indicated that the type of program and mode of presentation should be repeated next year. (2) Titles of scientific films were accumulated for listing in the Catalog of Scientific Films, a committee project described in the 1949 report.

(c) The following report was presented by Dr. C. W. Metz as representative of the Society on the Board of Governors of the American Institute of Biological Sciences:

The A.I.B.S. has now definitely come of age and has taken on numerous important and valuable functions. Although in the reports distributed from the Washington headquarters the more practical and utilitarian activities loom large, I would still emphasize, as I have done in previous reports, the special significance of the A.I.B.S. as an organization representing biologists in general in matters of national and international scope. This is exemplified particularly by the activities of the A.I.B.S. in connection with federal agencies such as Selective Service, and in negotiations with congressional and other governmental committees dealing with federal legislation involving biologists and biological activities. As an organization acting under the auspices of the National Research Council and the National Academy of Sciences, the A.I.B.S. can be and is beneficial to both biologists and the federal government.

Let me report first on the minutes of the meeting of the Board of Governors on May 9, 1950. This meeting was attended by all but three of the twenty members of the Board and lasted all day. The vice-chairman, Dr. F. P. Cullinan, acting as chairman at this meeting in the absence of chairman E. G. Butler, who was in Europe at the time. We gave intensive study to a whole series of matters of importance to biologists. The discussion was active and viewpoints were pressed vigorously. The activities of the A.I.B.S. have now become so extensive that a full time executive secretary is required. Dr. Clarence Hylander has been serving in this capacity since March 1950.

Among the subjects discussed, and where appropriate acted upon, are the following: (1) a biological potential survey to advise the Bureau of the Budget of the probable amount needed to support biological research under the National Science Foundation Bill (survey has been undertaken); (2) arrangements for sponsoring meetings of fourteen biological societies requesting such help at the forthcoming Columbus, Ohio meeting, September 11–13, 1950; (3) business office service and addressograph mailing system for biological societies; (4) organization of a placement service to help bring candidates into contact with available opportunities in biology; (5) admission of new member societies; (6) the matter of sponsoring meetings of biological societies in 1951, including acceptance of the invitation from the University of Minnesota; (7) the matter of associate membership in the A.I.B.S.; (8) endorsement of Biological Abstracts as a valuable agency and possible assistance to Biological Abstracts in obtaining funds; and (9) reports of committees.

Among the topics covered in the reports of committees were (1) finances of the A.I.B.S.; (2) cooperation with the Office of Naval Research and the National Research Council in regard to setting up advisory committees in biology; (3) progress of the Committee on the Handbook of Biological Data; (4) progress of Committee on Publication Problems.

Among the specific activities of the A.I.B.S. during the present year, I would emphasize the following. (1) The meeting of biological societies at Columbus under the sponsorship of the A.I.B.S. were, I believe, uniformly regarded as very

successful and satisfactory. I personally heard numerous comments to the effect that the A.I.B.S. arrangements had been very satisfactory and that the same system ought to be followed in future years. Incidentally, the percentage of paid registrations was unusually high. This together with advertising and exhibitors fees resulted in income practically meeting expenditures. Approximately 2,000 people attended the meetings. Since about 600 members were housed in university dormitories and most of the functions took place on the campus, there was considerable saving in expense and time. It is expected that at the Minneapolis meetings 2,000 persons can be housed on the campus.

(2) An extensive national scientific register is being undertaken in order to supply the Office of Manpower of the National Security Resources Board with full information concerning available biologists in the United States who have at least a bachelors degree plus two years additional experience or training. It is estimated that 14,000 non-duplicating memberships in the sixteen member societies of the A.I.B.S. and 8,000 in the affiliated societies will form a basic list in this activity, although a total of about forty-four societies are involved. In addition, a speciality check list is being made up.

(3) The biologist placement service mentioned above is now in operation. Details are given in the November 1950 A.I.B.S. Newsletter.

(4) Two new biological societies have been approved for affiliate membership.

(5) The A.I.B.S. has been instrumental in bringing about a contract between the Office of Naval Research and Biological Abstracts through which the Office of Naval Research will help finance the production of the annual indexes of Biological Abstracts — thus improving the quality and expediting the publication of these indexes.

In addition to items included in this report, the A.I.B.S. has continued important activities mentioned in my former reports.

(d) The following report was submitted by Dr. Horace W. Stunkard, the Society representative on the Division of Biology and Agriculture of the National Research Council:

The annual meeting of the Division of Biology and Agriculture convened in the Board Room of the National Academy of Sciences, National Research Council Building, 2101 Constitution Ave., Washington, at 9: 30 A.M., May 9th, 1950, with Doctor R. E. Cleland, Chairman, presiding.

In addition to the officers of the Division, there were representatives of 24 member societies, of the Federal Government, and representatives of the Divisions of Biology and Agriculture on the National Parks Association.

Doctor Cleland sketched briefly the purpose and functions of the National Research Council. It refers questions, originating in or referred to the Council for consideration, to the scientific societies for advice and then prepares reports for agencies of government. It serves a liason function between these scientific societies and the federal government. He announced changes in the executive and other committees and the appointment of a new committee on Radiation Biology.

The minutes of the last meeting were approved as circulated.

Doctor M. O. Lee, Executive Secretary, reported the actions and recommendations of the Executive Committee of the Division.

Reports were then presented by representatives of several boards and committees. The Agricultural Board has been reconstituted and enlarged to extend its fields of interest. Emphasis was placed on animal nutrition and health and on the prevention of losses by insects, and by plant diseases.

Frank P. Cullinan discussed the present status of the American Institute of Biological Sciences and the projects under consideration. The Institute has 16 member societies and 2 affiliated societies. Under contract with the Air Material Command, the Institute has started preparations of a Handbook of Biological Data. Assistance has been rendered to Biological Abstracts in preparation of indexes. The Institute has a committee on Publications, studying costs and a possible co-operative printing program for biological journals. It has aided in securing funds for type culture collection and plans for its reorganization of the Type Culture Collection. Doctor Nicholas reported further on the activities of the American Institute of Biological Sciences with reference to the armed services and the status of biologists in Selective Service.

Food and Nutrition Board. Reports were made by several committees, many of of which have published extensive surveys, others are now in preparation.

Doctor Henry Welch reported for the committee on American Type Culture Collection. Over $15,000 have been collected from industries; new equipment has been purchased and the price of cultures has been increased. The collection is now on a satisfactory financial basis.

Doctor Walford reported on activities of the committee on Investigation of Waste Disposal. Investigations have been conducted by the Fish and Wildlife Service and by the Woods Hole Oceanographic Institution. A preliminary report has been published and a full report will appear in the Reprint and Circular Series of the National Research Council.

Doctor Butler's letter of 24 May 1950, from the Stazione Zoologica at Naples to Doctor Bronk, commented on the welfare and activities of the Naples Station.

The committee on National Research Council Fellowships considered 46 applications, recommended 12 candidates of whom 3 were awarded fellowships.

There were 1462 applications for Fulbright awards, 130 in the Division of Biology and Agriculture. These applications were referred to 9 committees for screening, one of the 9 was the committee on Zoological Science composed of C. W. Metz, Chairman, and other members were D. L. Allen, E. G. Butler, K. P. Schmidt, H. B. Steinbach, H. W. Stunkard, L. A. Wolford, Paul Weiss and B. H. Willier. This committee considered applications of 22 candidates, of whom 5 received appointments. It was voted to reduce the number of screening committees from 9 to 4 and improve procedures.

The committee on Radiation Biology, is preparing a series of three volumes on (1) High Energy Radiation, (2) Ultraviolet Radiation and (3) Visible Radiation.

Chairman R. E. Cleland gave a progress report on the proposed committee on Conservation, authorized at the 1949 annual meeting.

Doctor D. W. Bronk, Chairman of the National Research Council discussed at some length the relation of the National Research Council and member societies.

He stated that, in addition to advice to federal agencies, the Council had organized committees and conferences to deal with many problems — including:

Committee on Atomic Casualities
Committee on Alcohol Problems
Committee on Undersea Warfare
Committee on Artificial Limbs
Committee on Human Reproduction
Committee on International Exchange of Persons
Committee on Growth
Committee on Maternal and Child Feeding
Committee on Highway Research Advisory Board
Committee on Pacific Science Board

At the conclusion of Doctor Bronk's remarks the members as a means of effecting closer relationships between the National Research Council and member societies unanimously adopted the following resolution:

> VOTED, that the Division urge the National Research Council to prepare a brochure for wide distribution to scientists, students, and the public at large upon the structure and organization of national science in the United States with special consideration of the composition and functions of the National Research Council.

(e) The following report was submitted by Dr. D. H. Wenrich, Society representative on the Board of Trustees of the American Type Culture Collection for the year 1950:

Owing to previous financial difficulties, a committee of the National Research Council collected funds in 1949 to aid the Collection. Most of the allotments from this fund were for the purchase of needed new equipment.

In accordance with the recommendations of the Committee of The National Research Council, prices of cultures were increased to $10.00 each with a discount of 70% to educational and charitable institutions, beginning with 1950. The new prices resulted in a decrease in the number of cultures sold, but provided an increase in revenue. Latest reports indicate that the year 1950 will end with a balanced budget.

In May, the Society of American Bacteriolgists nominated Doctor Carl Lamanna of Johns Hopkins University to fill the vacancy created by the resignation of Doctor L. A. Rogers. At the September meeting of the Board of Trustees, Doctor Lamanna was made chairman of the executive committee.

Doctor Ruth E. Gordon resigned as Curator in March, 1950. After careful consideration of candidates, Doctor Freeman Weiss was elected Curator at the September meeting of the Board. At this meeting also, it was voted to offer the position of mycologist-bacteriologist to Doctor Lloyd Phillips, who later accepted the offer. These appointments are expected to add considerable strength to the staff.

At the September meeting of the Board, a revision of the constitution was finally adopted. This included a provision for an enlargement of the Board to nine members, each to be elected for three years, three members to retire each year. The membership of the Board is to be constituted as follows:

2 to be nominated by the Society of American Bacteriologists, primarily to represent bacteriology and animal virology;
1 to be nominated by the American Association of Pathologists and Bacteriologists to represent primarily medical bacteriology;
1 to be nominated by the American Society of Zoologists primarily to represent protozoology;
1 to be nominated by the American Phytopathological Society, primarily to represent plant pathogens and plant virology;
1 to be nominated by the American Institute of Biological Sciences to represent fields of microbiology not listed above;
1 to be nominated by the Mycological Society of America, primarly to represent mycology;
2 to be nominated by the National Research Council, primarly to represent commercial and industrial microbiology.

In order to provide for the retirement of three members of the Board each year, a schedule was made out to inaugurate the new system. According to this schedule, the representative of the American Society of Zoologists is to retire at the end of 1951, hence a new representative will have to be nominated to begin service January 1, 1952.

It was voted that the foregoing committee reports be approved.

(f) Report by Dr. Franz Schrader of the Special Committee created by Dr. Romer to Consider Ways and Means of Improving the Present Situation Concerning the Reading of Papers at the Annual Meeting of the Society:

The Committee has tried to sum up the difficulties that attend the reading of papers in the following way:

1. The number of papers is now so great that the organization of the meetings has become a major task. Despite the grouping of papers in separate sessions running simultaneously, so many reports are read at these subsidiary sessions that very little time can now be allotted to discussion. This would seem to defeat one of the primary purposes of reading papers.

2. There can be little question that many of the papers have only a minor value and that frequently report is made of work that is far from finished. Both involve a waste of time.

3. The increasing specialization in biology has brought about the formation of smaller societies that are more restricted in their interests. Papers are often read before the Society of Zoologists which repeat or in part the subject matter of a paper reported elsewhere. Although this practice may have its uses, it usually involves duplication that is not warranted under the present crowded conditions.

We are of the opinion that the program difficulties of the Society are rooted too deeply to be eliminated by palliative measures. The fact of the matter is that most biologists also belong to subsidiary and more restricted societies and that it is these societies which primarly hold their loyalty and interest. That is where their most important papers are read, largely because such specialized audiences are in a better position to judge a paper in their special field. Little can be done to remedy this state of affairs, and it is doubtful whether it is advisable to make an attempt to do so.

We therefore should like to propose that the Society of Zoologists cease its efforts to have a program of papers of its own. Instead it might serve as a mother society, the chief purpose of which is to regulate and organize the programs of the various "daughter" societies, and to serve as a unifying force.

Since this proposal will probably not be accepted the Committee suggests certain measures which will alleviate the present congestion and perhaps improve the quality of the papers read. It should be repeated that such measures do not constitute a cure because, as already stated, the difficulties lie in conditions which cannot be controlled by the Society.

I. We are unanimous that only members and associate members should have the privilege of reading papers. The names of non-members should appear only on papers of which members or associate members are joint authors.

II. We are also agreed that each member or associate member should be limited to the reading of a single paper (whether he is sole or joint author).

III. We are further agreed that the publication of the abstracts of papers that are to be read only by title should be abolished without further ado. A member who does not attend the meeting to read his paper obviously does not understand that one of the chief purposes of such reports is to open them to fruitful discussion.

IV. The Committee makes one other proposal as an alternative to the three preceding palliative measures. This is to the effect that a program committee be appointed annually to go over all submitted abstracts in order to select a limited number for reading. The rest of the abstracts are to be published but not read. This measure would unquestionably eliminate crowding and improve the quality of the papers read.

However, there will be some difficulties in the execution of the last named project. In the first place, the program committee would be faced with a task of great magnitude. Secondly, the authors of papers "almost good enough to be read" would often resent their failure to gain a position of privilege on the program. As a result, there would be an annual spate of dissatisfaction which cannot but be harmful to the welfare of the Society. Nevertheless we feel that this alternative to the three palliative measures should be considered.

It was voted to table this report.

The American Society of Zoologists, in session in Cleveland, Ohio, December 27, 28, 29 and 30, 1950 wishes to acknowledge with thanks and appreciation its indebtedness to Western Reserve University and the local committee consisting of Dr. A. H. Hersh, Dr. James C. Gray and Dr. Daniel P. Quiring for the very efficient arrangements which contributed so effectively to the success of our meeting.

The meeting adjourned at 5:30 P.M.

WALTER N. HESS,
Secretary

LIFE AND ACTIVE MEMBERS

(* indicates life members of the Society; † indicates charter members of the American Morphological Society; mail addresses are in italics.)

ACKERT, JAMES EDWARD, A.B., A.M., Ph.D. (Illinois), Professor Emeritus of Zoology, and Parasitologist, Agricultural Experiment Station; Dean, Emeritus, Graduate School, *Kansas State College, Manhattan, Kan.*

ADAMS, A. ELIZABETH, B.A. (Mount Holyoke), M.A. (Columbia), Ph.D. (Yale), Professor of Zoology, *Mount Holyoke College, South Hadley, Mass.*

ADAMSTONE, FRANK BOLTON, B.A., M.A., Ph.D. (Toronto), Professor of Zoology and Head of Department, *317 Natural History Building, University of Illinois, Urbana, Ill.*

ADELMANN, HOWARD BERNHARDT, A.B., A.M., Ph.D. (Cornell), Professor of Histology and Embryology, Chairman, *Department of Zoology, Cornell University, Ithaca, N. Y.*

ADOLPH, EDWARD FREDERICK, A.B., Ph.D. (Harvard), Professor of Physiology, *School of Medicine and Dentistry, University of Rochester, Rochester, N. Y.*

AGERSBORG, H(ELMER) P(ARELI VON WOLD) K(JERSCHOW), B.S., M.S. (Washington), A.B. (Oslo), M.A. (Columbia), Ph.D. (Illinois), Director of the Agersborg Biological Laboratory and the ABL Teaching-Supply House, *511 City National Bank Building, Centralia, Ill.*

ALBERT, ALEXANDER, B.A. (St. Stephen's), M.A., Ph.D. M.D. (Harvard), Assistant Professor of Physiology, Mayo Foundation, University of Minnesota and Consultant and Head of Endocrinology Laboratories, *Mayo Clinic, Rochester, Minn.*

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Totals

Life members	2
Active members	896
Associate members	322
Grand total	1220

HISTOLOGICAL STUDIES OF HUMAN TESTES

I. THE DISTRIBUTION OF LIPIDS [1, 2]

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TWENTY FIGURES

INTRODUCTION

In human testes, there are demonstrable lipid granules in the fibroblast-like cells of the interstitial tissue, as well as in the cells of Leydig and in the seminiferous tubules. The fibroblast-like cells, then, are singularly different from the fibroblast found in connective tissues elsewhere, which do not normally show lipoidal inclusions. The cells of Leydig contain variable amounts of lipid, some being heavily lipoidal, others nearly free of lipids. In the seminiferous tubules, lipid granules are found in the cytoplasm of some spermatogonia, in the peripheral primary spermatocytes and at the base of Sertoli cells. These lipid droplets form a peripheral sudanophilic band (fig. 1). The lipids in the interstitial fibroblast-like cells are reactive to the Schultz test and are autofluorescent. In the cells of Leydig, some of the lipids are reactive to the Schultz test; they are autofluorescent and occasionally birefringent. Nearly all of the tubules contain

[1] This investigation was supported in part by a research grant, H 397, from the National Heart Institute of the National Institute of Health, Public Health Service.

[2] We are indebted to Dr. Charles Hawke, of Winfield, Kansas, for making it possible for us to collect this material.

Schultz reactive, autofluorescent and birefrigent lipids. This is presumptive evidence that the testes contain some unsaturated steroids. If the presence of unsaturated steroids in gonads really indicates the presence of hormones or their precursors (cf. Dempsey and Bassett, '43, Claeson et al., '48), it would appear that in human testes, the recognizable Leydig cells are not the only cells which contain testicular androgen. Whether or not the lipids described here represent sites of testicular hormones, their presence and possible importance, particularly in the fibroblast-like cells and in the cells of the germinal epithelium, should not be overlooked.

MATERIAL AND METHODS

The materials used were obtained from 11 total orchidectomies of men from 18 to 38 years of age. All of these men were mentally deficient and sex misdemeanants. Their general health appeared to be good. The tissues were fixed immediately after removal from the patients in neutral saline formaldehyde, and in formal-calcium of Baker ('44). Tissues fixed in formal-calcium were transferred to bichromate calcium of Baker ('46). For the study of autofluorescence, tissues fixed in saline formaldehyde were thoroughly washed; frozen sections 10 μ thick were mounted in non-fluorescent glycerin and observed under near-ultraviolet light (these observations were made no longer than two weeks after the tissues were collected). The tissues to be used for the other lipid studies were imbedded in gelatin and sectioned approximately 5 μ in thickness. For total lipids, sections were treated with Sudan black according to the method of Baker ('44). For neutral lipids, we used Nile blue sulfate (Cain, '47). Particular care was taken not to differentiate the sections too long in acetic acid which quickly removes the blue oxazine from lipids. If sections are kept in the acid rinse for one minute, all of the lipids remain colored pink. For unsaturated steroids, sections were treated with Schultz's method. (Sections were affixed to gelatinized slides and oxidized for three days in ferric alum; after blotting dry, one drop of

sulphuric acid was allowed to act for 30 seconds. The acid was then washed with acetic anhydride and the sections covered with a cover slip. Only the green or blue-green color was considered to be a positive test.) For the study of birefringent lipids, untreated frozen sections were mounted in glycerin, glycerin jelly and in levulose. For the demonstration of free cholesterol, tissues were treated with aqueous digitonin (Bennett, '40). Frozen sections of saline formaldehyde-fixed tissues were immersed for 12 hours in 0.5% digitonin, in 50% alcohol (Lison, '36) or in saturated alcoholic solution of digitonin. None of these tests gave birefringent digitonide crystals (in striking contrast with the results of Perlman, '50, in the testes of the rat).

OBSERVATIONS

Untreated frozen sections under ordinary light. In the interstitial tissue, there are many elongated fibroblast-like cells which contain refractile pale yellow cytoplasmic granules.

Most Leydig cells contain refractile cytoplasmic granules. These are usually small and spherical, but they may be of varied size and shape. In the larger cells, refractile granules are usually larger and more conspicuous. Leydig cells also possess variable amounts of a yellow brown pigment. Some occasional cells are heavily pigmented, and may be necrotic.

In the seminiferous tubules, just inside the basement membrane, there are numerous large and small yellowish refractile granules which form a peripheral band.

Treatment with Sudan black. The observations in the lipids of the 11 testes have been summarized in table 1.

Nearly all of the fibroblast-like cells in the interstitial tissue, regardless of their shape or size, contain cytoplasmic sudanophilic droplets (figs. 4 and 5). Except for their lipid inclusions, many of these cells are identical in shape with the fibroblasts in connective tissue elsewhere in the body. The fibroblasts in the tunica albuginea and in the septulae testis are free of lipids. In clusters of Leydig cells, fibroblast-like cells engorged with lipids are intermingled with

TABLE 1

		SUDANOPHILIA					
Case no.	Age	Leydig cells	Fibroblast-like cells	Seminiferous tubules	Schultz test	Bire-fringence	Auto-fluorescence
1	20	Mixed fine and coarse granules.	Variable amounts of lipid granules.	Distinct peripheral band.	Weak in Leydig cells. Strong in fibroblast and tubules.	In tubules only.	Some in Leydig cells. In all fibroblasts. Peripheral band in tubules.
2	30	Mostly heavily laden with coarse droplets.	As above.	Heavy peripheral band.	Strong in Leydig cells, fibroblasts and tubules.	Leydig cells and tubules.	Brilliant in Leydig cells, fibroblasts, and at periphery of tubules.
3	23	,,	,,	,,	,,	In tubules only.	As no. 1.
4	19	Mostly sparse fine granules and some coarse droplets.	,,	,,	,,	,,	,,
5	38	Mostly mixed fine and coarse granules.	,,	Very distinct peripheral band.	,,	,,	,,
6	19	Very fine and sparse granules.	,,	No distinct peripheral band.	In rosettes throughout germinal epithelium.	,,	Bright in fibroblasts, weak in Leydig cells and tubules.
7	32	Mixed fine and coarse granules.	,,	Distinct peripheral band.	Mostly in Leydig cells. Some in tubules.	Principally in tubules.	In Leydig cells and fibroblasts. Distinct peripheral band in tubules.
8	20	Mostly sparse fine granules.	,,	No disinct peripheral band.	Mostly in fibroblasts and tubules.	,,	Distinct in fibroblasts. Some in Leydig cells. Scattered in germinal epithelium.
9	18	,,	,,	,,	,,	,,	,,
10	19	,,	,,	,,	,,	,,	,,
11	19	,,	,,	,,	,,	Abundant in tubules only.	,,

them (fig. 3). Oftentimes, they surround capillaries and arterioles.

The cells of Leydig in any one testis usually show all possible degrees of sudanophilia (figs. 2 and 3). In some specimens they contain more lipid than in others. In case 2, for instance, many of the cells are full of very large misshapen lipid droplets, while in cases 3 and 8, the cells contain mostly delicate spherical lipid granules. The larger cells of Leydig usually contain more lipid inclusions than the smaller ones.

The larger dropets are more intensely sudanophilic than the delicate granules. While the larger droplets are colored after an exposure to Sudan of one-half minute, the smaller granules require at least 5 minutes. (Cain, '50, calls attention to the fact that coloration with Sudan depends upon the physical state of the object tested.)

The pigment in the interstitial cells is mildly sudanophilic. In those cells which contain abundant pigment, the yellowish color shows through and appears brownish.

Small, rounded mast cells, their cytoplasm full of highly refractile granules, are often numerous in the interstitial tissue. Scattered among these granules, and often clustered around the nucleus, there are variable numbers of delicate sudanophilic spherules (fig. 6) which resemble those figured by Wislocki and Dempsey ('46).

The intratubular sudanophilic droplets form a peripheral ring in the seminiferous tubules, just inside the basement membrane (fig. 1). These lipid droplets are found in the cytoplasm (usually subnuclear) of some spermatogonia, of peripheral primary spermatocytes (fig. 7), and of Sertoli cells (fig. 8). Some of the specimens show a more intense peripheral sudanophilic band than others. In case 6, the lipids are diffusely distributed in the cells of the germinal epithelium. The cytoplasm of the spermatogonia is usually free of visible lipids except in specimens 6, 8 and 9. The germinal cells above the peripheral ones contain delicate lipid granules. In the germinal epithelium, a few large, and perhaps moribund, cells are heavily lipoidal. Those sperma-

tocytes which are free in the lumen of the tubules, often contain large sudanophilic granules.

In the Sertoli cells, lipid droplets are aggregated at the base (fig. 8), and around the nucleus. In the cytoplasm which extends centripetally toward the lumen, small and barely visible lipid granules are scattered among the imbedded sperm heads.

Wislocki ('49) observes that the intratubular lipid droplets in the testis of the deer, are associated primarily with the Sertoli cells. This concept is shared also by Hanes and Rosenbloom ('11).

The very small lipid granules in the cells of the germinal epithelium, as in the Leydig cells, are more difficult to color with Sudan black than are the large droplets in the peripheral cells. They are also easily discolored by too long a rinse in 50% alcohol. The lipids of the peripheral sudanophilic band are easily colored with Sudan and resist even prolonged rinsing in alcohol.

Nile blue sulfate. After treatment with Nile blue sulfate most of the testicular lipids become colored blue. The lipid droplets in the fibroblast-like cells are blue, but some may be pink in heavily engorged cells. Some pink-staining droplets are seen in the larger lipid-laden Leydig cells. Some, but not all of the peripheral band of lipids in the tubules are colored pink. A large portion of the lipids in the testis, then, becomes colored blue. This is a reaction of dubious significance; it may represent lipids in a solid form since liquid lipids (neutral fats) are colored only by the pink oxazone fraction of Nile blue (Cain, '47). This is in contradiction to Hanes and Rosenbloom who believe that the peripheral intratubular lipid droplets are composed of "neutral fats."

Schultz test for unsaturated steroids. The harshness of this test does not allow accurate observations on the precise localization of those lipids which give a positive blue-green reaction. However, with care, certain trends can be observed in the location of the reaction.

The fibroblast-like cells give a positive test. These become conspicuous only in such specimens as 6 and 8 where the Leydig cells are weakly reactive.

The cells of Leydig show variable numbers of blue-green granules interspersed among brown ones, but some cells show no reaction (these may correspond to those cells which contain no visible lipid droplets). In case 2, nearly all of the larger cells showed bright green globules. In cases 6 and 8, the Leydig cells were nearly all negative.

All of the seminiferous tubules give a positive reaction, but this is not correlated with the heavy lipoidal accumulations seen with Sudan black. In cases 1, 2, 4, 5 and 7, the conspicuous lipid droplets at the periphery of the tubules turn a brown color, whereas the more diffusely distributed lipids turn a blue-green. In cases 6 and 8, the test reveals blue-green rosettes throughout the germinal epithelium.

Birefringent lipids. The larger and more lipid-laden, fibroblast-like cells in the interstitial tissues reveal a few spherocrystals. In the smaller cells, we found no briefringence. With the exception of case 2, where the cells of Leydig show an appreciable amount of anisotropy in the form of acicular and spherocrystals (fig. 9), the majority of the Leydig cells in other testes are isotropic. As a rule, anisotropy in cells of Leydig is so sparse as to be practically negligible.

Sperocrystals in variable numbers are seen in nearly all the seminiferous tubules (figs. 9 and 10). These tend to be more numerous toward the periphery of the tubules, but they do not correspond strictly with the lipoidal bands revealed with Sudan black. In most specimens, they can be seen throughout the germinal epithelium.

Autofluorescence. The autofluorescence of the testicular lipids is usually comparable with the lipids visualized with Sudan black.

The fibroblast-like cells in the interstitial tissue emit a bright yellow fluorescence. These are the most consistently fluorescent elements in the interstitial tissue. In specimen 8, for instance, where the cells of Leydig show a yellow light

of very low intensity, the fibroblast-like cells are the only brilliantly fluorescent elements in the interstitial tissue (these granules are so delicate that it is difficult to photograh them).

The cytoplasm of the cells of Leydig fluoresces with a yellowish light of medium to low intensity. Many cells, in addition to this basic ground fluorescence, contain variable numbers of coarse granules which fluoresce with a bright orange or yellow light (fig. 11). In cases 2 and 7, most of the Leydig cells fluoresce brillantly, while in cases 6, 8, 9, 10 and 11, they show little more than the basic ground fluorescence.

The distribution of fluorescent substances in the seminiferous tubules corresponds to that of the sudanophilic lipids (figs. 11 and 12). In cases 1, 2, 3, 4, 5 and 7, which show a marked peripheral sudanophilic band, bright orange fluorescent globules give the tubules a ringed appearance. In cases 6, 8 and 9, on the other hand, where the lipids are not concentrated heavily at the periphery, the fluorescence is diffuse in the germinal epithelium.

The basement membrane of the seminiferous tubules fluoresces with a green light of medium intensity. It is most distinct in number 5.

The ductuli efferentes. The epithelium forms centripetal folds which give the ducts a festooned inner surface. The ductuli efferentes which are about to enter the ductuli epididymides undergo a gradual transition and they have characteristics of both ductuli efferentes and ductuli epididymides. All of these ducts contain variable amounts of pigment, more abundant in some specimens than in others.

The cells of the ductuli efferentes are usually intensely sudanophilic (fig. 13). In the intermediate segment mentioned above, the lipids diminish gradually toward the ducts of the epididymis (fig. 14). Lipids are heaviest in the ducts of cases 1, 3, 4, 5, 7 and 8. In cases 6, 9, 10 and 11, the cells appear vacuolated — delicate lipid granules being scattered among the hyaline vacuoles. The lumina of the tubules are often full of sudanophilic substances. In numbers 6 and 9,

where the cells contain only fine lipid granules, the lumina are full of phagocytic cells, engorged with lipids.

In the connective tissue between those ducts which contain abundant lipid, there are clusters of large, lipid-laden phagocytes (fig. 13). These, as well as lipid containing fibroblasts, are absent in the connective tissue which surrounds the tubules containing scant amounts of lipid.

When treated with Nile blue sulfate, some pink droplets appear among blue-colored ones only in those cells which are engorged with lipid droplets.

When abundant, the lipids are birefringent (fig. 15). The anisotropy gradually diminishes in the intermediate tubules (fig. 16) and vanishes in the ductuli epididymides. The Schultz test gives comparable results, it being positive in the sites of heavy lipoidal accumulation and strong birefringence. The lipid-laden phagocytes in the surrounding connective tissue, likewise show birefringence and are positive to the Schultz test.

Under near-ultraviolet light the lipids emit a pale yellow green light of low intensity.

The ductuli epididymides. The tall pseudostratified columnar epithelium possesses variable amounts of fine lipid granules which are more numerous in some specimens than in others. When lipids are scant, they are restricted to the small, triangular basal cells and to the bases of the surface cells. When abundant, they fill virtually the whole cytoplasm. Scattered among the lipid granules, there are many non-lipoidal hyaline granules. The pigment is mildly sudanophilic.

The lipid granules in the epithelium are usually colored blue with Nile blue, but some larger droplets may color pink. These lipids are isotropic; rarely, the basal cells show birefringent crystals. There is no reaction with the Schultz test. Under near-ultraviolet light, the epithelial cells emit a greenish-yellow light of medium to low intensity.

DISCUSSION

Some of the demonstrable testicular lipids have the characteristics of unsaturated steroids. Although abundant digitonides have been demonstrated in the testes of the rat (Perlman, '50a, '50b), cat, guinea pig, rabbit and mouse (Pollock, '42), we failed to obtain birefringent digitonide crystals when sections or blocks of tissues were treated with digitonin. This may mean either that our methods were faulty, or that human testes contain only small quantities of free cholesterol.

Three points of interest stand out in this study: (a) The presence of lipid granules in the fibroblast-like cells in the interstitial tissue, (b) the variability in amounts of lipid inclusions in the cells of Leydig, and (c) the abundance of intratubular lipids, usually arranged in a peripheral band.

The intertubular tissue of the testes contains cells which resemble fibroblasts, but their contents of lipid droplets (which are reactive to the Schultz test, are autofluorescent, and sometimes birefringent) suggest that they may be intermediates between fibroblast-like cells and Leydig cells. In figures 17 to 20 we have arbitrarily arranged a graded series of cells which show such presumptive phases of transformation. In studies of testes removed whole at one operation, it is not possible to observe whether such a series of changes actually takes place.

An origin of Leydig cells from fibroblast-like cells has been described in detail by Hooker ('44), in the bull, and in several animals which have seasonal breeding habits by Rasmussen ('32). Moreover, in tissue cultures of testes of guinea pig (Esaki, '28) and in autogenous grafts of testis into ear chambers of rabbits (Williams, '50) Leydig cells have been observed to arise by a transformation of cells indistinguishable from fibroblasts.

It should be emphasized that the fibroblasts in the interstitial tissue are singularly different from fibroblasts in other organs. Even in the septulae testis, in the tunica albuginea,

and in the adnexa of the testes of the same subject, fibroblasts contain no demonstrable lipid droplets. The presence of Schultz-positive lipids in cells which appear similar to fibroblasts, and in others which somewhat resemble Leydig cells, suggests that these cells are either potentially capable of transforming into Leydig cells, or that they are actively transforming. This speculation does not rule out the possibilities that these cells may have an intrinsic secretory activity of their own, or that at least some of these cells may represent Leydig cells which have reverted to fibroblast-like cells.

With the information at hand, it is not possible to be sure of the fate of Leydig cells. Cowdry ('42) and Williams ('50) state they are postmitotics, since mitotic activity is practically never encountered. Perhaps they pass through complete cycles to and from fibroblast-like cells, or perhaps they are dissipated at the end of functional activity. Esaki ('28) in tissue culture and Williams ('50) in autogenous grafts report transitions and reversions. Gruenwald's ('46) studies of testes of human infants implies that cells of Leydig, which are numerous at birth, but disappear in the second quarter of the first year, may revert to fibroblast-like cells.

Since the cells of Leydig contain lipids which are sometimes birefringent and reactive to the Schultz test (cf. Nelson and Heller, '45) other authors have inferred that these cells are the sources of testicular hormones. Although this may be a valid deduction, our material presents certain inexplicable discrepancies. Many of the Leydig cells show lipid granules, which are usually Schultz positive, but only number 2 of all 11 specimens shows birefringent crystals (this is comparable to the findings of Perlman, '50b, in the testes of the rat). The Leydig cells were usually found to be autofluorescent, but in only a few cases did their fluorescence rival in brilliance that in the seminiferous tubules.

Intratubular lipids have been described in the testes of man, rat, dog and other animals by Kunze ('22) and recently by McEnery and Nelson ('50). In man nearly all of the

germinal cells contain fine lipid granules (with the exception of the transforming spermatids). In addition, large lipid droplets are usually amassed at the periphery of the tubule and occur in the cytoplasm of some spermatogonia in nearly all of the peripheral primary spermatocytes, and in the Sertoli cells. (Most authors believe that only the Sertoli cells contain intratubular lipids.) All of the tubules contain some birefringent crystals and lipids reactive to the Schultz test. The lipids amassed at the periphery, however, are usually isotropic and negative to the Schultz test, but they are strongly antofluorescent. The autofluoresence of these lipid droplets may be associated with the pigment dissolved in them (Wislocki, '49, interprets the autofluoresence in the testis of the deer as being due to lipochrome). The intratubular lipids which form the peripheral band may conceivably participate in the process of spermatogenesis, as suggested by Hanes and Rosenbloom ('11), Kunze ('22) and Perlman ('50b).

Since presumptive evidence obtained from morphological and cytochemical observations have implicated the cells of Leydig alone with the secretion of testicular hormones, it is difficult to assess the importance of the findings described in this paper. Undoubtedly, some of the discrepancies between these data and those obtained from the testes of other animals, are due to species differences (cf., Kunze, '22, Pollock, '42, Wislocki, '49). There should be a note of caution about interpreting cytochemical findings too liberally. If the demonstration of unsaturated steroids really indicates the presence of testicular hormones, then the fibroblast-like cells and the seminiferous tubules contain the hormones, as well as the cells of Leydig. In the first edition of their book, Maximow and Bloom ('30) favored the belief that the epithelial element of the seminiferous tubule is the source of testicular hormones. In the latest edition, however, the cells of Leydig are given preference (Maximow and Bloom, '48). It would appear from these findings, then, that the problem of the origin of testicu-

lar hormones is not settled and that final confirmation is lacking.

SUMMARY

1. Lipids demonstrable with Sudan black are present in the fibroblast-like cells of the interstitial tissue, in the cells of Leydig and in the seminiferous tubules. The fibroblast-like cells nearly always contain cytoplasmic sudanophilic granules. In the cells of Leydig, lipids may be abundant or absent. Nearly all of the cells of the germinal epithelium contain some cytoplasmic lipid inclusions. They are most abundant in some spermatogonia, in the peripheral primary spermatocytes and in the Sertoli cells, to form a distinct peripheral sudanophilic band.

2. In Sertoli cells, large lipid droplets are amassed usually beneath the nucleus. In the cytoplasm which extends toward the lumen of the tubules, there are dust-like lipid particles. Unlike the findings of other authors, the lipid content of these cells is not greater than that of the spermatogonia and the peripheral primary spermatocytes.

3. The lipids in the fibroblast-like cells of the interstitial tissue are reactive to the Schultz test and they are autofluorescent.

4. Comparable with the observation with the Sudan black, the Leydig cells may or may not be reactive to the Schultz test and show autofluorescence. In some testes, they contain birefringent lipids.

5. In the seminiferous tubules, the peripheral lipids are autofluorescent, but they are not Schultz reactive and they are isotropic. The other intratubular lipids are reactive to the Schultz test and birefringent.

6. These observations suggest that the histological criteria used for the demonstration of the testicular hormones in other animals are not tenable for human testes. If they were, then the presumptive sites of hormones should include the interstitial fibroblast-like cells and the seminiferous epithelium as well as the cells of Leydig.

7. The epithelium of the ductuli efferentes is laden with birefringent, Schultz-reactive lipid. That of ductuli epididymides is not.

LITERATURE CITED

BAKER, J. R. 1944 The structure and chemical composition of the Golgi element. Quart. J. Micro. Sci., *85:* 1–71.

———— 1946 The histochemical recognition of lipine. Quart. J. Micro. Sci., *88:* 463–465.

BENNETT, H. S. 1940 The life history and secretion of the cells of the adrenal cortex of the cat. Am. J. Anat., *67:* 151–227.

CAIN, A. J. 1947 The use of Nile blue in the examination of lipoids. Quart. J. Micro. Sci., *88:* 383–392.

———— 1950 The histochemistry of lipoids in animals. Biol. Rev., *25:* 73–112.

CLAESSON, L., E. DICZFALUSY, N. Å. HILLARP AND B. HÖGBERG 1948 The formation mechanism of oestrogenic hormones. III. Lipids of the pregnant rabbit ovary and their changes at gonadotropic stimulation. Acta Physiol. Scand., *16:* 183–200.

COWDRY, E. V. 1942 Problems of Ageing. 2nd ed., by E. V. Cowdry. Chap. XXIV: 626–658. Williams and Wilkins, Baltimore.

DEMPSEY, E. W., AND D. L. BASSETT 1943 Observations on the fluorescence, birefringence and histochemistry of the rat ovary during the reproductive cycle. Endocrinol., *33:* 384–401.

ESAKI, S. 1928 Über Kulturen des Hodengewebes der Säugetiere und über die Natur interstitiellen Hodengewebes und der Zwischenzellen. Ztschr. mikr. Anat. Forsch., *15:* 368–404.

GRUENWALD, P. 1946 Structure of the testis in infancy and in childhood. Arch. Path., *42:* 35–48.

HANES, F. M., AND J. ROSENBLOOM 1911 A histological and chemical study of fatty matters of normal and cryptorchid testes. J. Exp. Med., *13:* 355–364.

HOOKER, C. W. 1944 The postnatal history and function of the interstitial cells of the testis of the bull. Am. J. Anat., *74:* 1–37.

KUNZE, A. 1922 Das physiologische Vorkommen morphologisch darstellbarer Lipoide in Hoden und Prostata mit besonderer Berücksichtigung der Haussäugetiere. Arch. Mikroskop. Anat., *96:* 387–434.

LISON, L. 1936 Histochimie Animale. Gauthier-Villars, Paris.

MAXIMOW, A. A., AND W. BLOOM 1930 A Textbook of Histology. W. B. Saunders, Philadelphia.

———— 1948 Ibid.

MCENERY, W. B., AND W. O. NELSON 1950 Cytological studies on testicular lipids. Anat. Rec., *106:* 221–222.

NELSON, W. O., AND C. G. HELLER 1945 Hyalinization of the seminiferous tubules associated with normal or failing Leydig-cell function. Microscopic picture in the testis and associated changes in the breast. J. Clinic. Endocrinol., *5:* 13–26.

PERLMAN, P. S. 1950a The functional significance of testis cholestrol in the rat: effects of hypophysectomy and cryptorchidism. Endocrinol., *46:* 341–346.

———— 1950b The functional significance of testis cholestrol in the rat: histochemical observations on testes following hypophysectomy and experimental cryptorchidism. Endocrinol., *46:* 347–352.

POLLOCK, W. F. 1942 Histochemical studies of the interstitial cells of the testis. Anat. Rec., *84:* 23–29.

RASMUSSEN, A. T. 1932 Special Cytology. Vol. 3, 2nd ed., by E. V. Cowdry. Sec. XLII: 1673–1725. Hoeber, New York.

WILLIAMS, R. G. 1950 Studies of living interstitial cells and pieces of seminiferous tubules in autogenous grafts of testis. Am. J. Anat., *86:* 343–370.

WISLOCKI, G. B. 1949 Seasonal changes in the testes, epididymides and seminal vesicles of deer investigated by histochemical methods. Endocrinol., *44:* 167–189.

WISLOCKI, G. B., AND E. W. DEMPSEY 1946 Observations on the chemical cytology of normal blood and hemopoietic tissues. Anat. Rec., *96:* 249–278.

PLATE 1

EXPLANATION OF FIGURES

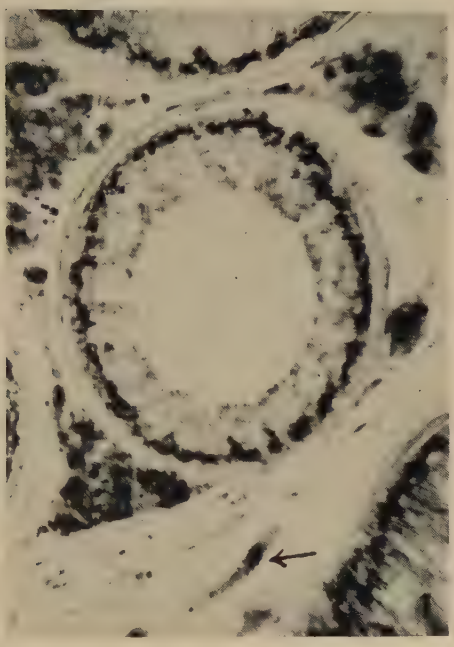
Frozen sections of tissues fixed in saline formaldehyde and treated with Sudan black.

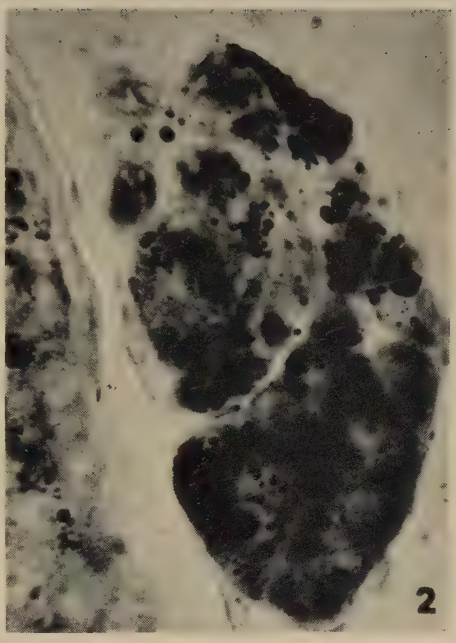
1 In the seminiferous tubules, note the peripheral sudanophilic band. In the interstitial tissue, sudanophilia in clusters of Leydig cells and in fibroblast-like cells (arrow). Testis of a 38-year-old man (case no. 5). × 200.

2 Cluster of Leydig cells to show heavy accumulation of coarse sudanophilic droplets. Testis of a 30-year-old man (case no. 2). × 670.

3 Sparse distribution of sudanophilic droplets in Leydig cells. Arrow pointing at fibroblast-like cell which is laden with lipid droplets. Testis of a 20-year-old man (case no. 1). × 1350.

4 Lipid droplets in fibroblast-like cells. Testis of a 38-year-old man (case no. 5). × 1800.

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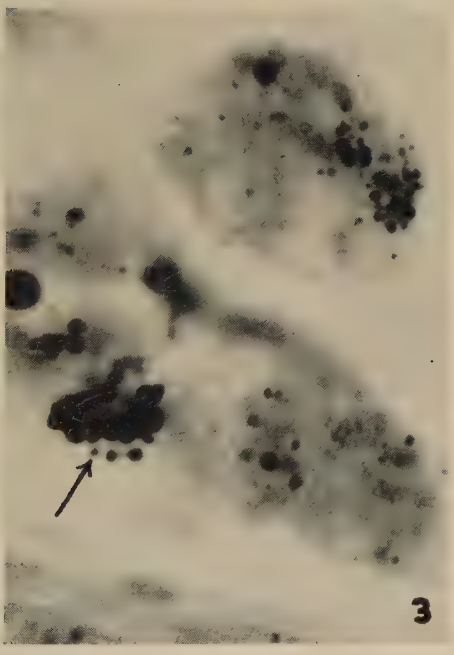
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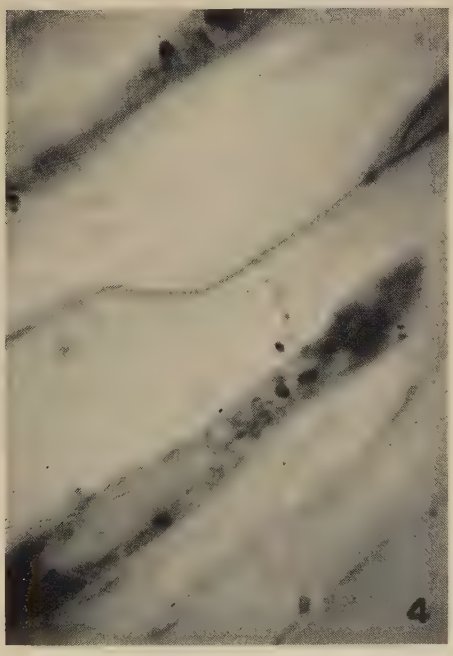
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PLATE 2

EXPLANATION OF FIGURES

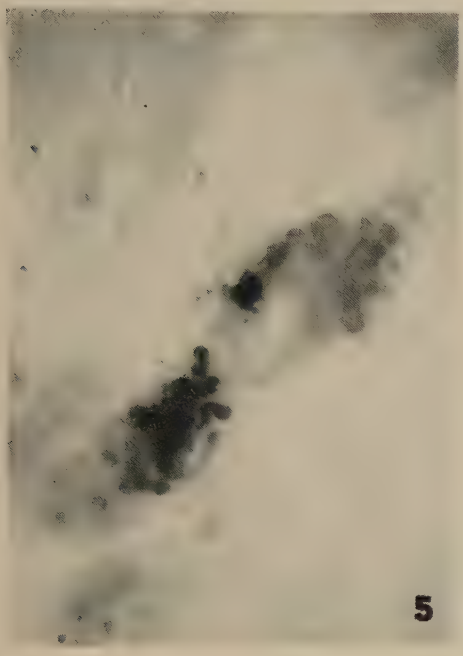
Sections of tissues fixed in saline formaldehyde and treated with Sudan black.

5 Fibroblast-like cell containing sudanophilic droplets. Testis of 38-year-old man (case no. 5). × 1800.

6 Mast cell from the interstitial tissue of the testis of a 38-year-old man. Observe the distribution of lipoidal droplets (case no. 5). × 1800.

7 Lipid droplets in the peripheral cells of the seminiferous tubules. The cell most clearly in focus is a primary spermatocyte. Testis of a 20-year-old man (case no. 8). × 1350.

8 Lipid droplets in the basal part of a Sertoli cell. Testis of a 20-year-old man (case no. 1). × 1350.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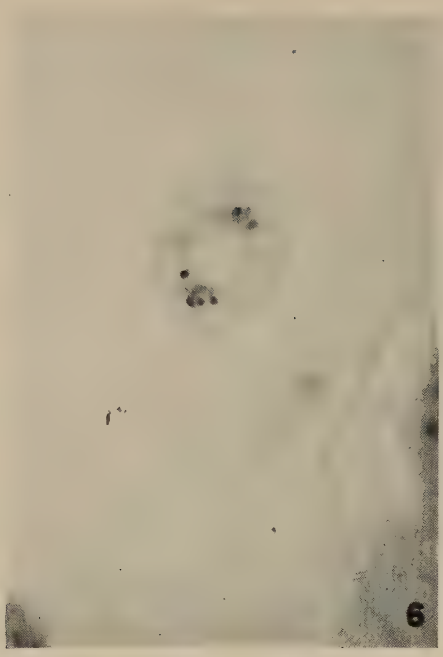
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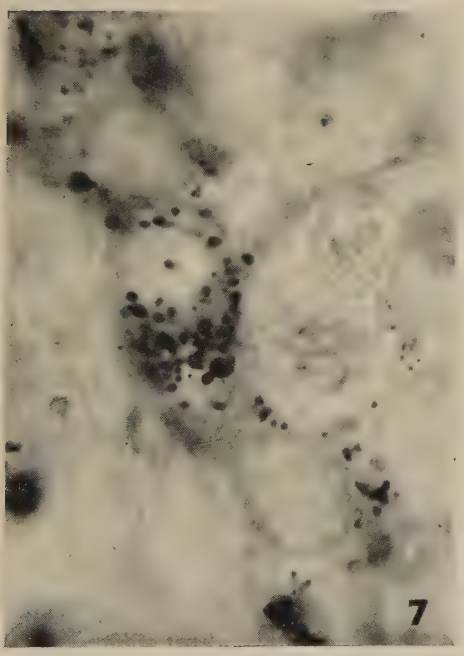
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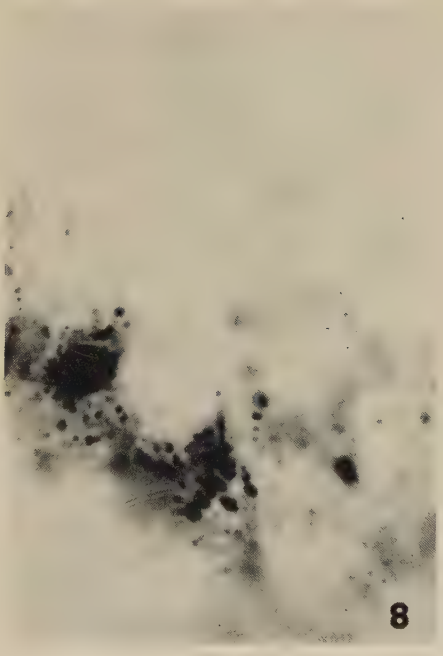
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PLATE 3

EXPLANATION OF FIGURES

Frozen sections of tissues fixed in saline formaldehyde and mounted in glycerin.

9 Birefringent crystals in Leydig cells and in seminiferous tubules. Testis of a 30-year-old man (case no. 2). × 150.

10 Birefringence only in seminiferous tubules. Testis of a 19-year-old man (case no. 6). × 150.

11 Autofluorescence in Leydig cells and seminiferous tubules. Testis of a 30-year-old man (case no. 2). × 150.

12 Autofluorescence principally in the periphery of seminiferous tubules. Observe the very clear basement membrane. Testis of a 38-year-old man (case no. 5). × 150.

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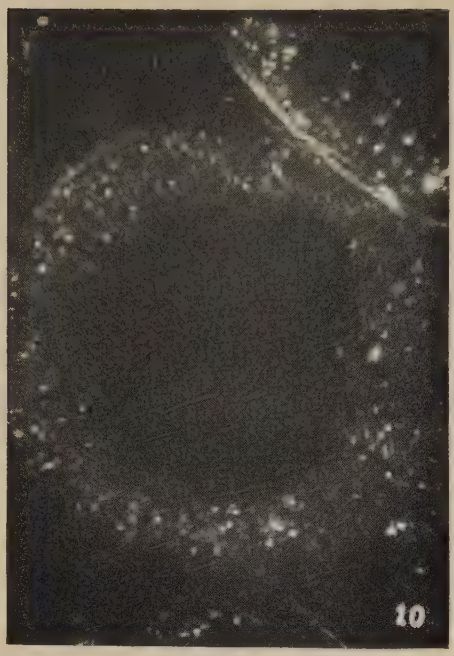
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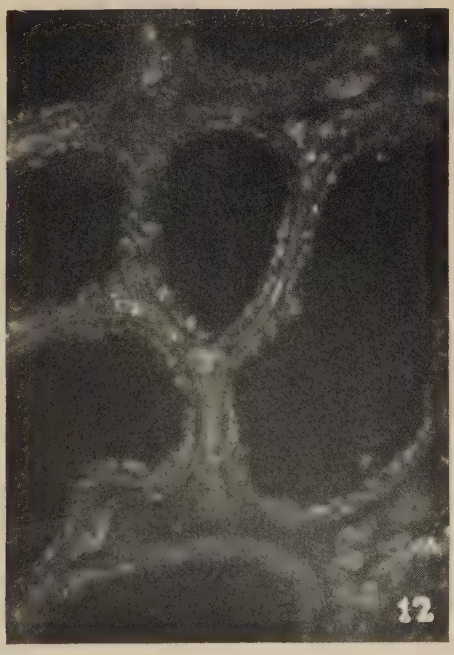
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PLATE 4

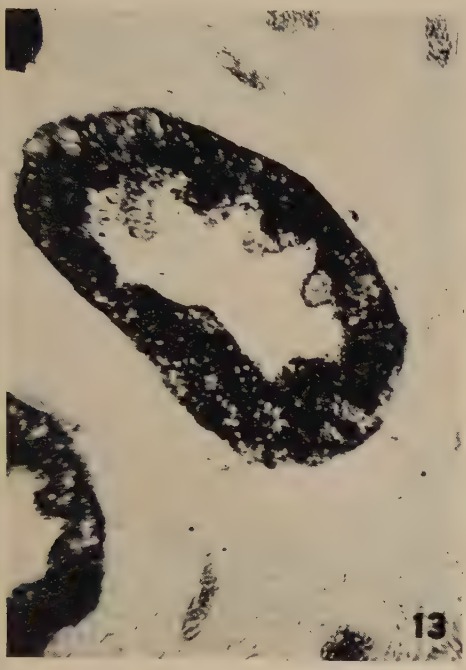
EXPLANATION OF FIGERES

13 Sudanophilia in tubule of ductus efferens. Note also lipids in macrophages in surrounding connective tissue. From a 20-year-old man (case no. 8). × 150.

14 Terminal segments of ductuli efferentes to show distribution of sudanophilic droplets in the epithelium. Compare with figure 1. Same section as in figure 13. × 150.

15 Birefringent lipids in ductuli efferentes. From a 20-year-old man (case no. 8). × 150.

16 Birefringent lipids in terminal segments of ductuli efferentes. Compare with figures 14 and 15. Same section as figure 15. × 150.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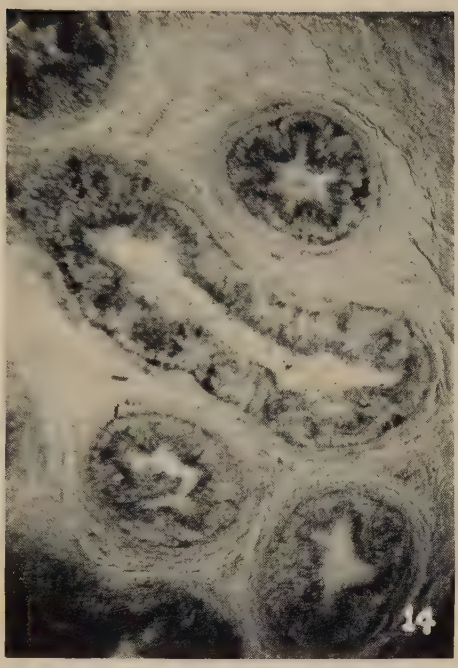
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PLATE 5

EXPLANATION OF FIGURES

All these figures are camera lucida drawings of cells from specimen number 3, gathered in groups to illustrate their morphological appearance and distribution of lipid droplets.

17 Fibroblast-like cells of different sizes and shapes. Note cytoplasmic lipid granules.

18 Cells which appear to be intermediates between fibroblast-like cells and cells of Leydig.

19 Leydig cells chosen particularly to show differences in lipoidal inclusions. Note cytoplasmic vacuoles in some of the cells.

20 Leydig cells nearly devoid of visible lipid inclusions.

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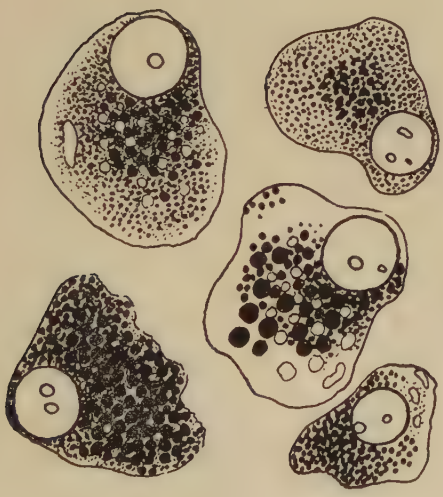

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REGENERATION OF SENSORY OLFACTORY EPITHELIUM AND NERVES IN ADULT FROGS

CARLTON G. SMITH
Department of Anatomy, University of Toronto, Toronto, Canada

ELEVEN FIGURES

The vulnerable position of the olfactory epithelium, and its importance as the sense organ for smell, are two considerations which make it of interest to know if olfactory epithelium can regenerate. The present study is an attempt to learn if regeneration is possible in one of the lower air breathing vertebrates, namely, the adult frog (Rana pipiens).

MATERIAL AND METHODS

Regeneration of olfactory epithelium was studied in preparations of the nasal region of two groups of frogs. In one group, comprising 64 specimens, the olfactory epithelium was destroyed by 1% zinc sulphate, and in the other group, comprising 32 specimens, a small portion of the epithelium was removed with an injection needle used as a punch.

Group 1. The right nasal cavity of each of these frogs was irrigated with 3 cm^3 of 1% zinc sulphate and the left was kept as a control. This was easily done because the nasal cavities of the frog do not communicate with each other, are smooth walled, and have well separated external nares and similarly small, well separated internal nares. The irrigation was achieved by applying the open tip of a medicine dropper to the internal naris and gently forcing zinc sulphate solution into the sac. The solution escaped from the sac by way of the external naris and, with the frog on its back, it

dripped away without entering the external naris of the other side.

Group 2. A circular disc of olfactory mucosa, 1 mm in diameter, was removed from both the right and left nasal sacs of these frogs by means of an injection needle which had been sharpened so that it could be used as a tubular punch. This hollow needle was inserted into the nasal cavity, by way of the internal naris, and directed against the olfactory epithelium in its roof. When in position it was tapped through the roof of the sac and into the skull to remove a slender cylindrical mass of tissue consisting of olfactory epithelium, tunica propria and bone.

The frogs in each of the above groups, 1 and 2, were all treated on the same day and the progress of regeneration was observed in each group by killing and examining three of them at a time during the following 98 and 64 days respectively. The specimens were fixed using 10% formalin, and transverse sections of the nasal region, 7 μ thick, were cut in paraffin and stained with haematoxylin and eosin. In the zinc sulphate experiment the brain of each frog, with the two olfactory nerves attached, was also saved for study. Serial cross sections of the nerves and olfactory bulbs were mounted and stained with haematoxylin and eosin.

OBSERVATIONS

Normal olfactory epithelium. The structure of the olfactory epithelium of the frog is essentially the same as that of higher vertebrates, including man, and is illustrated in figures 1 and 2. It is made up of sustentacular, basal, and olfactory sensory cells. The olfactory sensory cells, actually the cell bodies of the olfactory nerve fibers, are crowded several cells deep between a superficial layer of columnar sustentacular cells, and a deep layer of irregularly shaped basal cells. Each of the olfactory sensory cells has a process, corresponding to a dendrite, which passes to the surface of the epithelium between the sustentacular cells. On the surface it ends in a small vesicle from which arise the

long delicate olfactory hairs. The axonal process of each cell, the olfactory nerve fiber, passes between the basal cells to enter the tunica propria on its way to the brain. Within the tunica propria are located numerous tubular glands, called Bowman's Glands, which are characteristic of the olfactory mucosa in air breathing vertebrates.

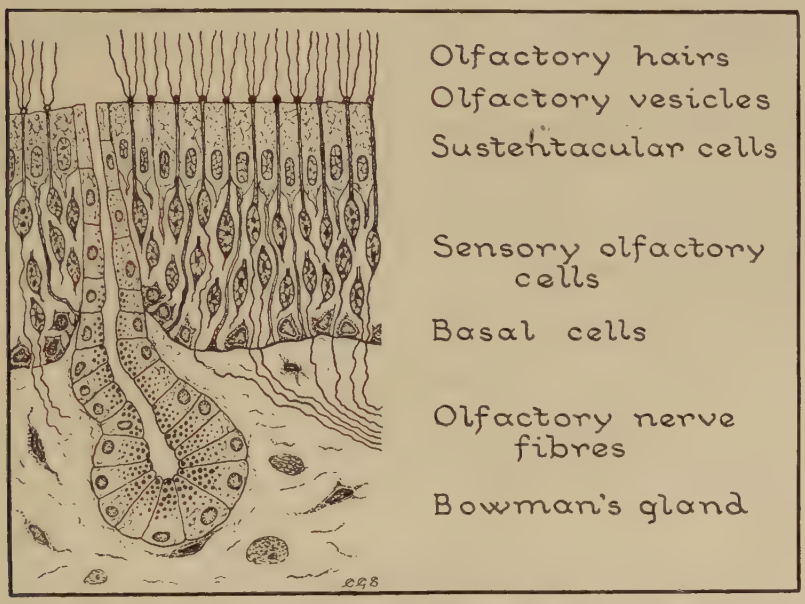


Fig. 1 A diagram illustrating the structure of the olfactory epithelium of the adult frog.

Regeneration of olfactory epithelium following its destruction by 1% zinc sulphate. A solution of 1% zinc sulphate causes the olfactory epithelium to degenerate and slough within two days. By the time this sloughing is completed the tunica propria is already covered by a newly formed layer of flattened cells. At first there are only a few of these cells and each one is stretched out to cover a relatively large area. Within 24 hours, however, they increase in number, are less attenuated and in some places overlap to make the epithelium more than one cell thick (fig. 3). At this stage

(three days after treatment with zinc sulphate) the continuity of the newly formed epithelium with the epithelium forming the ducts of Bowman's Glands is a conspicuous feature.

Proliferation of epithelial cells now continues at a relatively slow rate up to 14 days (fig. 4) and considerably faster thereafter until the 28th day. By the 28th day the epithelium has acquired almost its full complement of cells (fig. 5). At this stage the cells look much alike when stained with haematoxylin and eosin. They have large round nuclei, little cytoplasm and are irregularly arranged and closely crowded. Cell differentiation has begun, however, inasmuch as some olfactory vesicles are already present and sustentacular cells are becoming recognizable as a superficial layer of more or less cuboidal cells. It is interesting that only small numbers of mitotic figures are present throughout the entire period of cell proliferation. They are still found in the 34 day preparation and appear in all parts of the thickness of the epithelium and also in the cells of Bowman's Glands.

In the second 4 weeks of regeneration the cells progressively assume their characteristic structure and position. The sustentacular cells acquire a columnar superficial portion and form a palisade-like layer at the surface. The sensory olfactory cells beginning with those nearest the surface become fusiform, orient themselves with their long axes at right angles to the surface and develop superficially directed processes which end at the surface as the olfactory vesicles. The deepest cells of the epithelium, which remain as a residue of undifferentiated cells, form the now recognizable basal layer. This layer becomes progressively thinner as more and more of the sensory olfactory cells differentiate. Figure 6 is a section of the regenerated olfactory epithelium at the 56th day. At this stage the epithelium closely resembles normal olfactory epithelium, but its cells are more loosely arranged and its basal layer is thicker than normal. During the next two weeks maturation of the newly formed epithelium continues and by the 70th day the regenerated epithelium is identical in structure with that of the control.

Regeneration of olfactory nerve fibers after destruction of the olfactory epithelium by 1% zinc sulphate. The right and left olfactory nerves, each of which is a single filament less than a millimeter in diameter and about 3 mm long, course caudally side by side to reach the brain. Hence by embedding the forebrain and its attached olfactory nerves as a single specimen it is possible to cut cross sections of both nerves at the same time and at exactly the same level, and have them available for comparison in the same histological preparation. The left nerves in such a preparation serves as a control for the right nerve which is coming from the nasal sac in which the olfactory epithelium was destroyed. Although only the routine haematoxylin and eosin technique was used to stain the nerves it was possible to recognize small departures from the normal because both the control and the regenerating nerves could be included in the same low power field of the microscope.

Figure 7 is a cross section of a normal olfactory nerve. Some of the fibers are cut across and appear as very fine dots, but other fibers, which course in the plane of the section, form conspicuous interweaving bundles. The larger irregularly oval black dots are the nuclei of the sheath cells. This section (fig. 7) serves as a control for the sections of nerves illustrated in figures 8, 9, 10 and 11 respectively. All the sections were taken at a level just anterior to the olfactory bulbs.

Figure 8 is a section of a nerve three days after its associated olfactory epithelium was treated with zinc sulphate. The nerve fibers are fragmented and stain poorly. The nuclei of the nerve fiber sheath cells are, however, conspicuous and appear to be more numerous. In figure 9, 14 days after the olfactory epithelium was destroyed, the degenerating nerve fibers have all disappeared and the nuclei of the sheath cells are swollen and very numerous. At this stage a few scattered regenerating fibers are already present. By the 28th day (fig. 10) regenerating nerve fibers are much more numerous and the nuclei in the section are smaller and less

crowded. During the next 4 weeks there is a progressive increase in the number of olfactory fibers and on the 56th day (fig. 11) the cross section of the regenerating nerve closely resembles the control (fig. 7). By the 70th day the cross section of the regenerating nerve and that of the control cannot be distinguished.

Regeneration of olfactory epithelium to replace a punched out portion 1 mm in diameter. Following the removal of a small disc of olfactory epithelium with its supporting tunica propria, the lost tissue is replaced, initially, with blood clot. During the next few days the cells of the epithelium bordering the punched out area lose the specialized characteristics that identify them as sustentacular, sensory, or basal cells and mitotic figures appear among them. The cut edge of the epithelium bordering the wound is now a source of regenerating epithelial cells. Migration of these cells to close the gap in the epithelium is delayed until the blood clot in the wound is replaced by newly formed connective tissue. Hence it is not until the 15th day that the hole in the epithelium is bridged and then only by a single layer of attenuated cells. With the formation of this layer of cells regeneration proceeds as it did in the zinc sulphate treated frogs. The time relations are also similar. Thus at the 31st day the epithelium is made up of round, closely crowded, undifferentiated cells, and at the 64th day the epithelium resembles normal olfactory epithelium except that it has a thicker basal layer and its cells are more loosely arranged. The end stage of regeneration was not observed because unfortunately, frogs were not kept longer than 64 days after the operation.

DISCUSSION

The results of this study reveal that the olfactory epithelium of the frog can regenerate within 70 days after the whole of the epithelium within one nasal cavity is destroyed. This finding is of interest inasmuch as a regeneration of olfactory nerve cells is involved and also because it opens the

possibility that regeneration of olfactory epithelium may occur in higher vertebrates.

In regard to the regeneration of the olfactory nerve cells the question arises as to their origin. In the experiment in which the olfactory epithelium was destroyed by 1% zinc sulphate the olfactory nerve cells, as well as the other cells of the new epithelium, appear to arise from surviving cells of Bowman's Glands. This source of new nerve cells is a little difficult to accept and it may be that some basal cells of the epithelium survived destruction by zinc sulphate and that these, like ependymal cells, can give rise to both nerve and supporting cells. The experiment in which a small part of the olfactory epithelium plus its tunica propria and contained glands of Bowman were cut away did not help to identify the cells from which the new epithelium can regenerate. In this instance all the cells at the edge of the wound appeared to revert to an embryonic state and share in the production of the new epithelial cells.

It is of interest to compare the regeneration of the olfactory neuro-epithelium of the frog with the regeneration of the retinal neuro-epithelium of the salamander as described by Stone ('50). He was able to show that the pigment cells of the outer coat of the retina served as the germinal layer from which all the retinal nerve and supporting cells developed. In this case one of the daughter cells of a dividing pigment cell lost its pigment and multiplied to form the new epithelial cells. The other retained its pigment and remained as a retinal pigment cell. It is conceivable that the cells of Bowman's Glands similarly may give rise to germinal cells from which the olfactory neuro-epithelium can regenerate.

Finally, although regeneration of olfactory epithelium is possible in the frog, there is some evidence to suggest that it cannot regenerate in the rat, monkey or man. Thus, in rats, large patches of olfactory epithelium fail to regenerate after they are destroyed by 1% zinc sulphate (Smith, '38). In these cases the olfactory epithelium is replaced by non-sensory columnar epithelium. Similarly, in monkeys scattered

patches of olfactory epithelium may fail to regenerate after being destroyed by 1% zinc sulphate (Schultz, '41). Lastly, in man, patches of olfactory epithelium are replaced commonly by ciliated columnar epithelium after they are destroyed by inflammatory processes (Kolmer, '27). In the light of these findings it is evident that in rats, monkeys and man regeneration of olfactory epithelium, if it can occur, is much less vigorous than in the frog.

SUMMARY

Regeneration of the frog's olfactory epithelium was observed (a) after all the epithelium within one nasal cavity was destroyed by 1% zinc sulphate, and (b) after a small portion of the epithelium and its associated tunica propria were cut away. In (a) the new epithelium appeared to regenerate from surviving cells of Bowman's Glands located in the tunica propria. In (b) all the epithelial cells bordering the wound appeared to share equally in the formation of the new epithelial cells. Regeneration is completed within 70 days.

The olfactory nerve fibers degenerate and disappear following the destruction of the olfactory sensory cells. During the third week new nerve fibers begin to reappear in the olfactory nerve and by the 70th day the section of the nerve close to the olfactory bulb resembles the section of a normal nerve.

ACKNOWLEDGMENTS

I should like to thank Professor J. C. B. Grant for his helpful suggestions and kindly criticism throughout the course of this investigation. I should also like to acknowledge my indebtedness to Mr. George Ross for his very valuable assistance.

LITERATURE CITED

Kolmer, W. 1927 Geruchsorgan, in von Möllendorff, W., Handbuch der mikroskopischen Anatomie des Menschen, Berlin, Julius Springer, *3:* 192–249.

Schultz, E. W. 1941 Regeneration of olfactory cells. Proc. Soc. Exp. Biol. and Med., *46:* 41–43.

SMITH, C. G. 1938 Changes in the olfactory mucosa and the olfactory nerves following intranasal treatment with one per cent zinc sulphate. Canadian Med. Assn. J., *39:* 138–140.

STONE, L. S. 1950 Neural retina degeneration followed by regeneration from surviving retinal pigment cells in grafted adult salamander eyes. Anat. Rec., *106:* 89–109.

PLATE 1

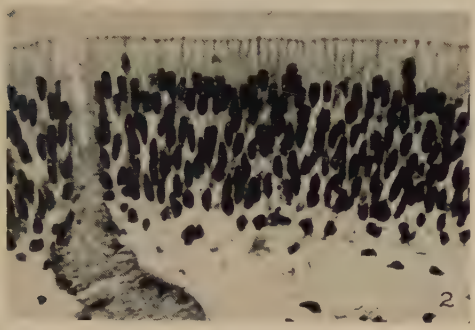
EXPLANATION OF FIGURES

2 Normal olfactory epithelium. Control. × 310.

3, 4, 5, and 6 Olfactory epithelium 3, 14, 28, and 56 days, respectively, after applying 1% zinc sulphate. × 310.

7 Cross section of a normal olfactory nerve. Control. × 70.

8, 9, 10, and 11 Cross sections of olfactory nerves 3, 14, 28 and 56 days, respectively, after the olfactory epithelium was treated with 1% zinc sulphate. × 70.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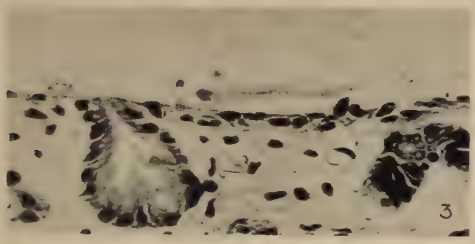
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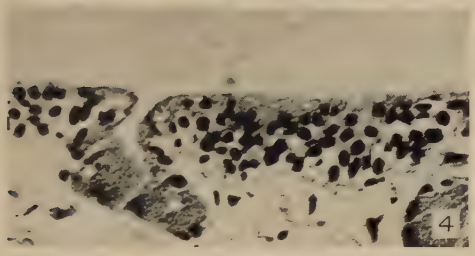
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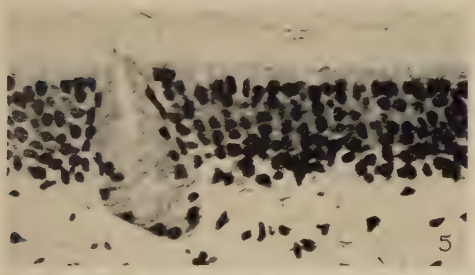
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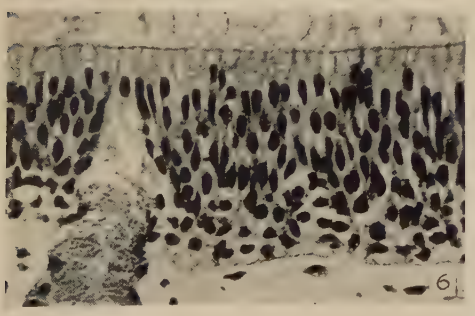
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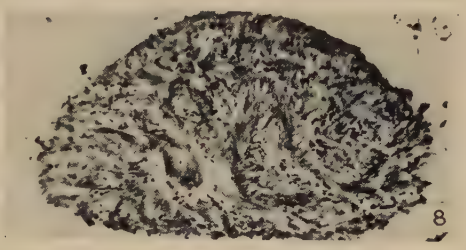
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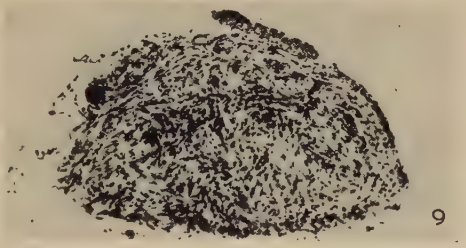
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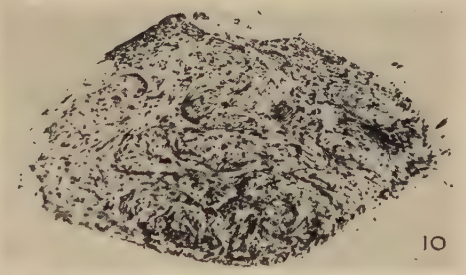
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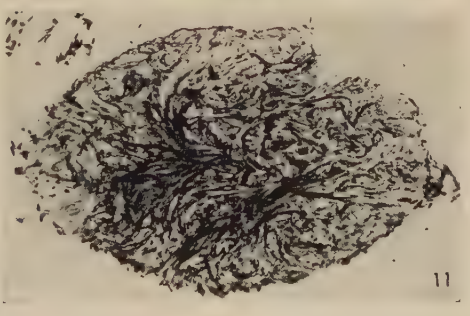
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THE OSSIFICATION OF THE MIDDLE AND INTERNAL EAR OF THE GOLDEN HAMSTER (CRICETUS AURATUS)[1]

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FOUR FIGURES

INTRODUCTION

Although the literature on the development and morphological relations of the ear region in mammals is very extensive, there remains much of a very desirable nature to be done on this subject including a clarification of a number of misinterpretations.

Summaries and discussions of the ear region of mammals generally include those of van Kampen ('05), de Beer ('37) and Gaupp ('11), the latter concentrating on the processus anterior of the mammalian malleus.

Papers concerned with the ear region of certain mammals only, are those of McClain ('39) who outlined the development of the ear in a marsupial (the opossum); Bast and Anson ('49) who compiled a volume on the development and anatomy of the human ear; Ridewood ('23) who studied the ear region in developing whale skulls; Cockerell, Miller and Printz ('14) who described and compared rodent auditory ossicles with those of Insectivora said to possess a "low type of malleus" similar to that of Marsupials in that the malleus is united to the ectotympanic ring; Jenkinson ('11) who was concerned mainly with the cartilaginous development of mouse

[1] Aided by a General Research Grant from the Graduate Council of Oregon State College and published with the approval of the Oregon State College Monographs Committe, Research Paper no. *166*, Department of Zoology, School of Science.

ear bones; Strong ('25) and Johnson ('33) who made ear ossification studies in the rat and mouse respectively; and Dorland (1878) who, in his investigations on *Cricetus frumentarius,* concluded that unlike most other rodents, the orbicular apophysis mallei was absent in the Cricetinae.

The ossification study of the early hamster skeleton by Beatty and Hillemann ('50) did not include a complete investigation of the ear region. The present paper is restricted to the ossification of the internal, middle and external ear along with associated portions of the hyoid arch of the golden hamster, *Cricetus auratus.*

MATERIALS AND METHODS

The 225 animals for this study, obtained from a colony established in the Department of Zoology at Oregon State College, were fed a diet consisting of vegetables, dog biscuits, whole grain, salt licks and water.

The hamsters were mated in the evening sometime between 9 and 12 P.M. and the exact time of mating recorded. The animals were sacrificed at the end of 24 hour intervals following mating, except for a few half-day stages.

The specimens were prepared as outlined by Beatty and Hillemann ('50) except for the fact that the specimens were left in the stain for 2 to 6 days and destained in a 0.5% KOH in lieu of acid. A weaker KOH solution was used for the smaller embryos. In addition 6 vascular injection preparations (three latex, three India ink) were prepared along with a dozen dry skulls of various ages.

OBSERVATIONS

Malleus: *Ossification.* The initial ossification in the malleus occurs on the 15th day of gestation and lies medial to the upper end of the anterior horn of the U-shaped ectotympanic. The position of this initial ossification in relation to Meckel's cartilage and its perforation by the chorda tympani is very similar to that pictured by Gaupp ('11) in the rabbit and seems to be the condition for mammals in general. This

ossification becomes a portion of the definitive malleus and is homologous with the prearticular (goniale, post opercular) of reptiles and birds. (See pl. 1, fig. 4.) Goodrich ('30) points out that this perforation of the prearticular by the chorda tympani may be observed in the lower tetrapods. Ridewood ('23) mentions that the prearticular arises as a typical membrane bone and that its ossification may spread later to the cartilage of the malleus. Similarly, McClain ('39) notes in the opossum that the prearticular fuses with the cartilaginous malleus and that the ossification center in the prearticular spreads to the cartilage of the malleus. Only one ossification center was observed for the malleus (in the prearticular portion) of the hamster. Thus in the hamster also, a cartilage bone (malleus) is ossified by extension from an adjacent membrane bone (prearticular). In man, the malleus is said to ossify from two centers (de Beer, '37).

On the first postnatal day the prearticular ossification has extended anteriorly to the chorda tympani foramen, and then spreads caudad to the cephalic process of the malleus on its way to the head of the malleus. By the third day the head and the entire anterior process which includes the processus cephalicus, lamina and processus gracilis, are nearly completely ossified.

The shapes of the articular surfaces of the malleus and incus are defined on day 3 but a layer of cartilage still separates the incus and malleus. This condition is reminiscent of the thick chondral plates which make up the incudo-malleolar joint of children, as reported by Bast and Anson ('49).

The articular head continues to enlarge and by the 5th day the prearticular portion of the malleus has extended its limits downward medially toward the midpoint of the anterior horn of the ectotympanic.

Ossification spreads slowly in the rest of the malleus until the 8th day when the base of the manubrium (retroarticular process of reptilian articular) is reached. The manubrium is fully ossified by day 11.

On day 9 the prearticular portion of the malleus becomes firmly attached on its medial side in a circumscribed area to an anterior extension of the anterior cochleo-canalicular center of the petrosal. At about 25–30 days the prearticular fuses with the medial aspect of the anterior horn of the ectotympanic and adheres to it rather than to the petrosal when the bulla is removed. A similar fusion has been shown by Ridewood ('22) for the whale and by McClain ('39) for the opossum.

An examination was made also of the skulls of a 23-day white rat (pl. 1, fig. 2-f) and adult mouse, *Mus musculus* (pl. 1, fig. 1-e), and it was found that the mallei of both had a prearticular portion which secondarily united with the ectotympanic as in the golden hamster. If an attempt is made to remove the malleus from the ear after the fusion of the prearticular portion with the ectotympanic, a break will readily occur at the weak spot where the prearticular is continuous with the anterior process of the malleus (processus cephalicus plus lamina plus processus gracilis), and the prearticular is left adherent to the ectotympanic. This fragility may explain the failure of Doran (1878) and Cockerell et al. ('14) to picture, in different species of rodents, the prearticular portion of the malleus.

Inspection of a late human foetus in this laboratory disclosed a long anterior process on the malleus as described by Doran (1878). No literature was found which mentions whether the anterior process (including the prearticular in human anatomical usage) similarly fuses with the ectotympanic. Thus it remains a question whether this processus anterior in man degenerates entirely or only into ligaments at the narrowest point thereby leaving part of the malleus (the prearticular portion) attached to the ectotympanic.

On the 11th day the processus muscularis is ossified on the lower posterior surface of the cephalic peduncle at about the same level as the processus brevis mallei. In the adult this processus muscularis is hardly discernible presumably due to differential growth of adjacent areas.

Malleus: *Anatomy.* The definitive hamster malleus bears a rounded head except for a deeply excavated articular surface on its postero-ventral aspect (pl. 1, fig. 2). The cephalic peduncle is sturdy and three planes of lamellar bone extend from the anterior surface of the head and peduncle of the malleus and comprise the anterior process of the malleus; these are the processus cephalicus, the lamina and the processus gracilis. The prearticular portion of the malleus originated just distal to the apex of the lamina and in the angle formed by the planes of the processus cephalicus and processus gracilis. The proximal end of the prearticular bears the chorda tympani foramen. This prearticular portion which earlier is attached to the petrosal, later fuses with the medial aspect of the anterior horn of the ectotympanic and usually breaks away from the malleus when the ectotympanic is lifted from the skull. Extending ventrally from the cephalic peduncle is the manubrium. It is dagger-shaped and bimarginate; the medial margin is curved with its convexity facing mediad while the lateral margin is straight and adherent to the tympanic membrane. A thin lamina of bone, concave from an anterior view, lies between these margins. The processus brevis manubrii mallei is very small, and the processus muscularis for the attachment of the tendon of the tensor tympani muscle is found as a small mound on the posterior aspect of the processus brevis. No orbicular apophysis is present on the malleus of the golden hamster; this accords with the findings of Dorland (1878) and Cockerell et al. ('14) for the *Cricetinae* in general.

Malleus: *Ossiculum accessorium mallei.* On day 2, two adjacent dots of ossification appear on both sides of the animal *inside* the skull in an area bounded by the antero-ventral surface of the petrosal, the alisphenoid and the ectotympanic (pl. 1, figs. 2-g, 4-o). In some specimens of day 9, these islands have fused and enlarged into a shoe-sole shaped structure; in others the ossiculum accessorium mallei became united to the free posterior margin of the squamosal but in most instances it lay free. By day 14 this structure is considerably

enlarged and may assume the shape of a boomerang with the legs directed dorsad. The posterior leg may extend beyond the posterior margin of the sqamosal to make a light attachment to the antero-medial surface of the petrosal.

This ossification may be the ossiculum accessorium mallei of van Kampen ('05) who regarded it as the representative of the coronoid. Watson ('16), Broom ('16) and Ridewood ('22) suggest that it may represent the supra-angular. van Kampen states that the ossiculum accessorium mallei may be found between the squamosal, alisphenoid and petrosal, and immediately against the dura mater. A similar position for this ossification in the hamster would identify it as the ossiculum accessorium mallei which, however, in contrast with the sheep (van Kampen, '05), does not become in any way associated with the malleus. Ridewood ('22) shows that the ossiculum accessorium mallei of the whale Balaenoptera fuses with both the ascial process of the prearticular (goniale) portion of the malleus and the ectotympanic.

Incus: *Ossification.* The incus, homologue of the reptilian quadrate, begins to ossify on the second or third postnatal day as a small center, which in relation to the definitive ossicle, lies on a ridge of the head of the cartilaginous incus between the processus brevis and the articular surface (pl. 1, fig. 4-i). Ossification spreads slowly until day 7 when it has included the processus longus incudis (stapedial process, crus longus incudis). On this same day the processus brevis incudis (crus breve incudis), which represents the otic process of the palatoquadrate, is also ossified, and points toward the pit in the ossified petrosal to which it is attached by a fine ligament. By day 8 the processus longus (stapedial process) has ossified merely to the head of the stapes and the peduncle of the Sylvian apophysis (lenticular process) is ossified on the 11th day. Day 12 brings ossification to the apophysis. The incudo-stapedial articular surfaces are completely ossified by day 17 and, as in rodents generally, the articulation between the incus and stapes remains free. The incus in man is said to ossify from two centers (de Beer, '37).

Incus: *Anatomy.* The articular surface of the incus opposite the malleus is extensive; the processus brevis is very short but massive with a small spicule of bone at its apex. The processus longus (stapedial process) is of moderate length and bears a wide but thin peduncle in continuity with an oblong Sylvian apophysis bearing a flat articular surface resting against the head of the stapes (see pl. 1, figs. 2, 3-h).

Stapes: *Ossification.* The stapes, homologous in part with the hyomandibula of fishes, and with the otostapes of the sauropsid columella, initiates its ossification on day 5 in three centers, one in the foot plate and one each in the crura. This contrasts with the statement in de Beer ('37) for the stapes of man which ossifies from the two crural centers and with the contradictory claim of Bast and Anson ('49) for man in whom the stapes is said to ossify from one center in the footplate. By day 6 the stapedial centers in the hamster have coalesced and on day 9 the crural centers have united inter se on the underside of the neck. On day 11, ossification has proceeded up from the base of the neck. The anteroventral crus is more sturdy in comparison with its posterdorsal mate. No bony canal is laid down between the crura for the stapedial (facial) branch of the internal carotid artery. By day 17, the head of the stapes is completely ossified.

No evidence of either Paauw's cartilage (representing the hyostapes) or the os quartum (an ossification in Paauw's cartilage) was found in the tendon of the stapedius muscle. Spence's cartilage, above the chorda tympani and between the stapes of hyoid cornu, was noted.

Stapes: *Anatomy.* The completed stapes is a light structure of little substance since the crura are thin-walled incomplete cylinders with their open sides facing the intercrural aperture. Unlike that of man, the anteroventral stapedial crus of the hamster is usually arched. The neck of the stapes is short and the stapedial head is a flat oval. A stapedial process arises from the stapedial neck near its juncture with

the posterodorsal crus and serves for the insertion of the stapedius muscle which extends posterodorsally to its origin on the petrosal. The transverse base has a convexity facing the fenestra ovalis (fenestra vestibuli); its margin is thin and elliptical (see pl. 1, figs, 1-b, 2, 3-h).

Ectotympanic: *Ossification and derivatives.* The ectotympanic, a membrane bone homologous with the angular of the lower jaw of reptiles, begins to ossify on day 15 (prenatal) in the form of a horeshoe open dorsolaterally (pl. 1, fig. 4-e). On day 2 (postnatal) ossification has extended the arms and the dorsal end of the anterior member then lies at a level slightly dorsal to that of the upper limits of the prearticular. By the 5th day the dorsal end of the anterior ectotympanic limb has expanded into a plane just lateral to the head of the malleus. At this stage the ectotympanic has assumed the form of a truncated cone whose larger aperture faces the lower region of the internal ear.

By the end of the 7th day the posterior horn has extended obliquely anterodorsally to reach a point immediately lateral to the posterodorsal crus of the stapes. On day 8 this horn has extended beyond the stapes to lie lateral to the processus longus incudis (stapedial process).

On the ventromedial edge of the truncated cone, a narrow strip ossifies dorsomedially toward the lower limits of the cochlea and represents the beginning formation of the tympanic bulla. (See pl. 1, fig. 1-a.) The bulla has extended its association with the ectotympanic nearly to the dorsal ends of its limbs. By day 11 the bulla has been elaborated nearly to the internal ear capsule and on day 12 it reaches the internal ear posterodorsally. On day 14 the anterodorsal portion of the bulla completes the ventrolateral wall of the cranium between the alisphenoid in front, the petrosal behind and dorsally, and the basisphenoid medially. The bony Eustachian tube is circumscribed as a notch in the bulla at its anteroventral margin just dorsolateral to the hamulus of the pterygoid and ventral to the posterolateral corner of the basisphenoid. It remains an incomplete foramen after day 13.

Another notch is formed (carotid canal) in the bulla on its medial border where it contacts the base of the petrosal. The stapedial (facial) artery enters here (pl. 1, fig. 1-a, b, c), and passes forward within the middle ear cavity ventral to the stylomastoid foramen. It continues through a bony canal elevated on the posterior bank of the fenestra ovalis and then passes between the crura (intercrural aperture). There is no intercrural bony canal as in many other rodents such as Spermophilus. From the crura the artery travels medially to the incus and exits through the anterior wall of the petrosal to continue forward as the sphenopalatine artery.

Day 10 marks a lateral extension of ossification from the original ectotympanic horseshoe to form the beginning of the bony external auditory meatus (pl. 1, fig. 1-a). At this time a difference in texture can be seen between that of the bulla and that of the bony ectotympanic anlage, which is laid down in curved parallel spicules while that of the bulla appears diffusely granular.

On day 15 a notch is generally found at the low point on the edge of the external auditory meatus. In some later specimens a complete foramen is found in the hamster as in guinea pigs; but the foramen is rare in adult hamsters.

On the inner or medial surface of the bulla there extends on day 11 a low curved ridge of membrane bone along the course of the lower or medial edge of the original ectotympanic. This becomes the annulus tympanicus (pl. 1, fig. 1-a) for the support of the tympanic membrane and is complete on day 21. Thus in the hamster the entire bulla is of membrane bone elaborated as an extension medally from the ectotympanic anlage and does not arise from an endotympanic cartilage bone (metatympanic), not identified in the hamster. Both the annulus tympanicus and the bony shell surrounding the external auditory meatus also arise as membrane bone extensions from this same rudiment.

Internal ear: *Ossification.* On prenatal day 14 there appear two small calcareous deposits, one dorsal to the other.

These are the beginnings of the two otoconia (otoliths), one of which belongs to the macula of the utriculus, the other to the macula of the sacculus (see pl. 1, fig. 4-u and 4-s).

The first ossification centers appear on day 2. One center, the posterior cochlear, is medial and posterior to the posterior horn of the ectotympanic. Another center, the posterior canalicular, appears in the petrosal medial to the posterior cochlear center. The third center, the anterior cochleocanalicular, appears anterior to the utricular and saccular otoliths.

By day 3 the posterior cochlear center has expanded and joined with the anterior cochleocanalicular center which has sent down a process (prefacial commissure) over the anteromedial border of a 4th center, the medial cochlear center of the cartilaginous cochlea. The medial cochlear center unites with the posterior canalicular center.

On day 4 a 5th center, the anterior cochlear, appears on the anterior aspect of the cochlea. The anterior and posterior cochlear centers have each formed a fraction of a hemisphere in their respective areas and have nearly joined, but the posterior cochlear center is the larger of the two. The process (prefacial commissure) being sent down by the anterior cochleocanalicular center has reached the anterior portion of the posterior cochlear center on its medial surface. The internal aperture of the facial canal is seen just lateral to this commissure and the internal acoustic meatus lies posteroventral to the internal facial canal. Ossification has proceeded in such a manner that the anterior cochleocanalicular and posterior canalicular centers are also fused with the posterior cochlear center. The anterior cochleocanalicular center has extended laterally and is ossifying around the horizontal (lateral) semicircular canal.

On day 5 the anterior cochleocanalicular and posterior cochlear centers have so united on the lateral aspect of the petrosal that the fenestra ovalis which accomodates the stapedial footplate is outlined except for a notch at the extreme posterodorsal region. The posterior cochlear center has expanded and united with the posterior canalicular center and

the stylomastoid foramen is completely outlined posterior to the fenestra ovalis. This posterior cochlear center lies on the posteromedial surface of the cochlea lateral to the lateral wing of the basi-occipital and anterior to the anterior process of the exoccipital. The bony labyrinth of the cochlea has so progressed that the enclosed spiral can be clearly seen.

By day 8 the ossification is progressing upwards from the anterior cochleocanalicular and posterior canalicular centers toward the anterior semicircular canal. Two new centers have arisen; one lies on the lateral aspect of the posterior canal, and is the lateral center of the posterior semicircular canal. The other center lies on the outer surface of the lateral semicircular canal and is the intermediate center of the horizontal canal.

By day 9 these two centers have united with the lateral center of the posterior semicircular canal. On day 10 the mastoid process of the petrosal is beginning to form from the posterior canalicular center just above the stylomastoid foramen. On day 11 the ossification is completed around the anterior and posterior semicircular canals. On the medial aspect of the petrosal and ventral to the anterior semicircular canal is seen the paraflocculär fossa (pl. 1, fig. 3-i). There is an extension of the petrosal just ventral to the middle region of the lateral semicircular canal which unites with the flat surface of the uppermost end of the posterior horn of the ectotympanic and forms the styloid process in part. The ossification of the petrosal is complete except for a portion of the lateral wall in the region of the semicircular canals. This area of the skull is being walled over by extensions of ossification from the anterior cochleocanalicular center anterior to the posterior canalicular center, from the intermediate center of the horizontal canal and from the lateral center of the posterior semicircular canal.

By day 12 the walling over is almost complete in the lateral area of the petrosal and by day 15 the side wall of the cranium in this region is complete.

Hyoid arch elements associated with the ear

The tympanohyal begins to ossify on day 12 as a horizontal bar which lies immediately above the dorsal end of the posterior horn of the ectotympanic. It lies in Spence's cartilage extending from the stapes to the hyoid cornu. On day 15 the tympanohyal fuses with a styloid process from the lateral center of the lateral semicircular canal to form the definitive styloid process extending horizontally caudad as a ventral border to the stylomastoid foramen. Thus the definitive styloid process is compounded of the tympanohyal and an extension of the petrosal and does not involve the stylohyal. Also on day 12 the stylohyal begins to ossify in several fragments in Spence's cartilage immediately behind the upper end of the posterior horn of the ectotympanic. In the adult the stylohyal fragments are tied by connective tissue to the posterior surface of the bulla.

Table 1 records the earliest observed ossification in the ear and associated structures.

TABLE 1

First appearance of ossification centers in the golden hamster

CENTERS AND EVENTS	AGE IN DAYS	
	Prenatal	*Postnatal*
I. Malleus and associated structures		
Articular surface of head of malleus		3
Lamina		5
Processus gracilis		5
Manubrium		9
Processus muscularis		11
Processus brevis manubrii mallei		11
Prearticular portion of malleus with chorda tympani foramen	15	
Ossiculum accessorium mallei		2
II. Incus		
Dorsal end		2
Processus longus incudis		5
Processus brevis incudis		7
Sylvian apophysis		11
Peduncle		11

CENTERS AND EVENTS	AGE IN DAYS	
	Prenatal	*Postnatal*
III. Stapes		
2 crural centers and 1 footplate center		5
Head of stapes ossified		8
Margin of footplate outlined		8
IV. Ectotympanic and associated stylohyal		
Ectotympanic anlage	14	
Bulla formation		8
Eustachian foramen		8
Carotid canal		12
Facial canal		12
External auditory meatus		10
Annulus tympanicus		11
Stylohyal		12
V. Petrosal and associated tympanohyal		
Utricular otolith (calcified)	14	
Saccular otolith (calcified)	14	
Posterior cochlear center		2
Posterior canalicular center		2
Anterior cochleocanalicular center		2
Prefacial commissure		3
Medial cochlear center		3
Anterior cochlear center		4
Facial canal outlined		4
Internal acoustic meatus outlined		4
Fenestra ovalis incompletely outlined		5
Stylomastoid foramen completely outlined		5
Lateral center of the posterior semicircular canal		8
Intermediate center of the horizontal semicircular canal		8
Basic mastoid process		10
Paraflocular fossa outlined		11
Tympanohyal		12

SUMMARY

1. Two hundred and twenty-five skeletons of the golden hamster *(Cricetus auratus)* varying in age from day 13 prenatal to the adult were prepared for a study of the ossifications in the ear and associated portions of the hyoid arch.

2. The malleus ossifies from one center, the prearticular homologue, by means of which it becomes united to the medial aspect of the anterior horn of the ectotympanic. The ossiculum accessorium mallei was found but the obicular apophysis was absent.

3. The incus appeared in one center and the stapes in three.

4. The ectotympanic bony anlage gave rise by extensions to the annulus tympanicus, the bony external auditory meatus and the tympanic bulla bearing the cartotid canal and Eustachian tube in the form of grooves adjacent to the petrosal. No evidence of an endochondral endotympanic (metatympanic) was found. The stylohyal, developed in Spence's cartilage, became attached to the posterior wall of the bulla.

5. The first indications of the petrosal arose in the form of the calcareous utricular and saccular macular otoliths (otoconia). The petrosal proper was formed from 7 separate centers which in turn defined the parafloccular fossa, prefacial commissure, basic mastoid process, internal auditory meatus and several foramina. The tympanohyal fused to the basic mastoid process of the petrosal to form the definitive mastoid process.

LITERATURE CITED

Bast, T. H., and B. J. Anson 1949 The Temporal Bone and the Ear. Charles C. Thomas, Publisher.

Beatty, M. D., and H. H. Hillemann 1950 Osteogenesis in the golden hamster. J. Mammal., *31:* 121–134.

Broom, R. 1916 On the structure of the skull in Chrysochloris. Proc. Zool. Soc. Lond., 449–459.

Cockerell, T. D. A., L. I. Miller and M. Printz 1914 The auditory ossicles of American rodents. Bull. Am. Mus. Nat. Hist., *33:* 347–380.

de Beer, G. R. 1937 The Development of the Vertebrate Skull. Clarendon Press, Oxford.

Doran, A. H. G. 1878 Morphology of the mammalian ossicula auditus. Trans. Linnean Soc. (Lond.) 2nd series, Zoology, *1:* 371–497, pl. 58–64.

Gaupp, E. 1911 Beiträge zur Kenntnis des Unterkiefers der Wirbeltiere: I. Der Processus Anterior (Folii) des Hammers der Säuger und das Goniale der Nichtsäuger. Anat. Anz., *39* (4–5): 97–135.

Goodrich, Edwin S. 1930 Studies on the Structure and Development of Vertebrates. MacMillan and Co., London.

JENKINSON, J. W. 1911 The development of the ear bones in the mouse. J. Anat. and Physiol., *45:* 305–318.

JOHNSON, MYRA L. 1933 The time and order of appearance of ossification centers in the albino mouse. Am. J. Anat., *52:* 241–271.

KAMPEN, P. N. VAN 1905 Die Tympanalgegend des Säugetierschädels. Morph. Jahrb., *34:* 321–722.

MCCLAIN, JOHN A. 1939 The development of the auditory ossicles in the opossum *(Didelphys virginiana).* J. Morph., *64:* 211–266.

RIDEWOOD, W. G. 1923 Observations on the skull in foetal specimens of whales of the genera Megaptera and Balaenoptera. Phil. Trans. Roy. Soc. Lond., *B 211:* 209–272.

STRONG, R. M. 1925 The order, time and rate of ossification of the albino rat *(Mus norvegicus albinus)* skeleton. Am. J. Anat., *36:* 313–356.

WATSON, D. M. S. 1916 The monotreme skull: a contribution to mammalian morphogenesis. Phil. Trans. Roy. Soc. Lond., *207:* 311–324.

PLATE 1

EXPLANATION OF FIGURES

1 (a) Medial aspect of right ectotympanic showing the carotid canal (groove), Eustachian tube (groove), bulla, annulus tympanicus, external auditory meatus and malleus fused to anterior horn of ectotympanic via the prearticular portion; note chorda tympani foramen. Adult, × 8.

(b) Left lateral view of petrosal with stapedial (facial) artery injected with latex and passing through the bony facial canal and intercrural aperture. Adult, × 8.

(c) Right lateral view of petrosal. Adult, × 8.

(d) Right lateral view of petrosal with malleus, incus and stapes in situ. Adult, × 8.

(e) Medial aspect of left ectotympanic of a mouse *(Mus musculus)* bearing the malleus fused to the anterior horn of the ectotympanic via the prearticular portion; note the foramen of the chorda tympani in the prearticular. Adult, × 5.8.

2 (f) Lateral aspect of left malleus of rat to show the orbicular apophysis, processus cephalicus, lamina, processus gracilis, peduncle, head, manubrium, processus brevis and prearticular portion. Adult, × 8.

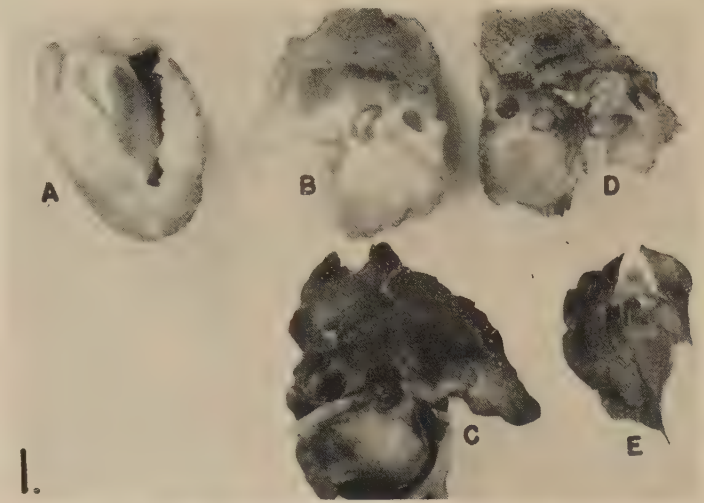
(g) Boomerang-shaped ossiculum accessorium mallei removed from skull of 18-day postnatal hamster. × 8.

Remaining items in figure 2 are various views of the hamster malleus, incus and stapes. Adult, × 8.

3 (h) Right lateral view of petrosal with stylomastoid foramen, facial canal, stapes in fenestra ovalis, sylvian apophysis of incus in contact with head of stapes, and crus breve incudis attached to petrosal and cochlea. Adult, × 8.

(i) Medial aspect of left petrosal showing anterior semicircular canal, paraflocculer fossa, facial commissure, and internal acoustic meatus. Adult, × 8.

4 Lateral view of right side of ear region in a 2½ day animal (postnatal), showing the anterior cochleocanalicular center (a), the posterior cochlear center (c), the alisphenoid (d), the ectotympanic (e), the incus (i), the posterior canalicular center (n), the ossiculum accessorium mallei (o), the prearticular (p), the saccular otolith (s) and the utricular otolith (u). × 12.



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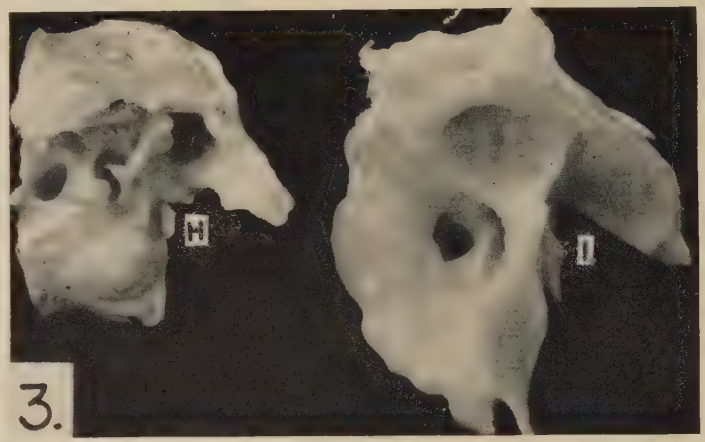

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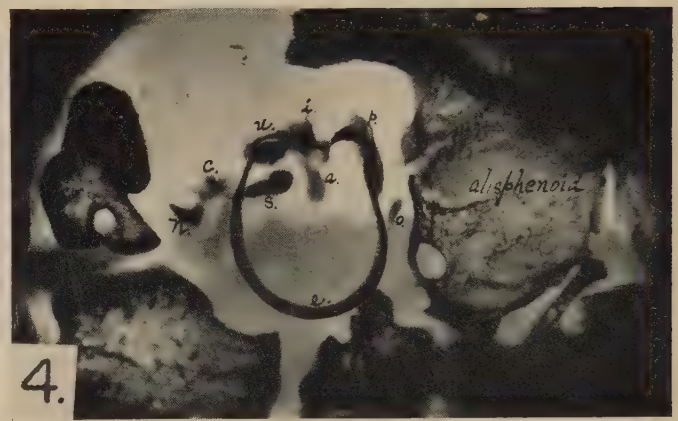

4.

THE CRICOESOPHAGEAL TENDON

A RECOMMENDATION FOR ITS INCLUSION IN OFFICIAL ANATOMICAL NOMENCLATURE

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ONE FIGURE

The tendon of origin for the striated muscle of the esophagus is an important gross structure which has been known for many years, yet has received no designation in official anatomical nomenclature (Kopsch, '37) and is not adequately dealt with in the majority of the standard textbooks of gross anatomy.

Both the internal and the external muscle layers of the more cranial portion of the human esophagus consist of striated muscle. That each of these muscle layers may be expected to have a fixed attachment, as is true generally of striated muscle, was brought out by Gillette (1872) and again by Abel ('13). This attachment is largely to the median ridge on the posterior surface of the cricoid lamina, by means of a well-defined, constant tendon (fig. 1).

REVIEW OF THE LITERATURE

Luschka (1862) stated that most of the fibers of the longitudinal muscle layer of the esophagus originate from a flat, elastic tendon which is attached above to the cranial end of the median ridge of the cricoid lamina, and widens below to overlap the medial edges of the posterior cricoarytenoid muscles. He included an illustration.

Henle (1866) likewise mentioned the tendon, and illustrated it diagrammatically. Schmauser (1866) gave a detailed des-

cription of the origin of the longitudinal fibers from this narrow, membranous band, which he recognized as having the function of a tendon. It is probable that further search of 19th century literature would locate earlier descriptions than these of a structure so readily observed. The tendon is not mentioned by Boyer (1815) or by Santorini (1775).

A B

Fig. 1 The cricoesophageal tendon. Drawings from the author's dissections. In A the pharynx and esophagus have been opened in the midline posteriorly and the mucosa removed. The tendon has been left attached to the cricoid lamina to show its posterior surface. In B the tendon has been pulled free from the cricoid lamina to display its anterior surface.

Gillette (1872) named this structure the "cricoesophageal tendon." The term "tendon (or ligament) of Gillette" occurs in more recent French and American literature. The following is a free translation of Gillette's description:

There is a median fascicle or "brush" of muscle fibers (radial or fan-shaped) arising between the two posterior cricoarytenoid muscles on the small longitudinal ridge on the posterior part of the cricoid cartilage. This attachment is made through the intermediary of a tendon which we will call the *cricoesophageal tendon.* It is an elastic aponeurotic lamella, which serves as an anterior or suspensory ligament of the esophagus, and which, located just under the superior

border of the cricoid, adheres intimately to the median ridge on the posterior surface of the cricoid cartilage.

This tendon, which the microscope shows is formed by fibers of laminated tissue containing a high proportion of elastic elements, gives rise to all the fibers of the middle fascicle, partly from its inferior extremity (vertical fibers) and partly from the sides (oblique fibers). Thus, the fibers are given off gradually from the entire height of the tendon, in the manner of the nerves of the cauda equina of the spinal cord. They become less and less oblique as one goes superiorly, and they diverge downwards and backwards like a fan.

To see and dissect this tendon, it suffices to open the pharynx and esophagus on the posterior surface; upon exerting light downward traction on the esophagus, a distinct cord is felt behind the cricoid; one has only to detach the mucosa and occasionally some circular fibers to see this small elastic membranous septum . . .

Arising from these diverse insertions, the fibers of the cricoesophageal muscle descend, the vertical ones going anteriorly; all the others go downwards and backwards, and after a course of 4 to 5 cm they fuse so as to form, in spreading out all around the esophagus, a longitudinal, muscular membrane almost uniformly spread out . . .

Laimer (1883) again described this fibroelastic band, and the distribution of the muscle fibers originating from it. In the dog, cat and the majority of animals, as in man, this band is the principal place of origin for the external muscle layer of the esophagus, but there is a minor additional origin from that portion of the inferior constrictor muscle which arises from the cricoid cartilage (cricopharyngeus muscle). In a few species (e.g., marten) the situation is reversed, the cricopharyngeus muscle being the major, and the tendon the minor, source. The tendon is entirely lacking, according to Laimer, in the pig, horse and rabbit, where the external layer originates from the sides of the cricoid cartilage or from the pharynx.

Attention was directed by these earlier authors to the manner in which the muscle fibers destined for the external coat leave the tendon: only a delicate ventral band descends craniocaudally from the base of the tendon; the majority of the fibers diverge from the sides of the tendon as two strong, lateral, longitudinal bands, leaving intervening ventral and

dorsal triangles of only thin muscle content at the cranial extremity of the esophagus. Moreover, two minor additional origins for the external muscle layer of the esophagus, in the form of a fascicle on either side from the cricopharyngeus muscle, are also described. The longitudinal muscle, then, originates from three places, the principal one of the three being the cricoesophageal tendon. The tendon, in turn, gives rise to three bands, of which the two lateral form the principal mass of the longitudinal muscle. Confusion resulted, and it was erroneously stated that the longitudinal muscle of the esophagus originated by three bands, each of significant size: a midline ventral one from the tendon, and two lateral ones from pharyngeal musculature. It was this wrong conception, current in the textbooks of the time, and continued to the present in one of our standard texts (Gray, '48, p. 1188) that Birmingham (1898) aimed to correct. Birmingham described only the two lateral longitudinal bands diverging from the tendon, denying any ventral band of muscle or any contribution to the longitudinal muscle from pharyngeal musculature.

Birmingham also gave a clear analysis of the origin of the circular fibers: ventrally they form a sharp, free border beneath the tendon, dorsally they blend with the cricopharyngeus muscle, while laterally fibers of the upper one-sixteenth inch of the circular layer attach to the common tendon of the longitudinal fibers, and thus to the cricoid lamina. Birmingham was one of the original contributors to Cunningham's textbook ('02), and a satisfactory diagrammatic figure redrawn from his paper appears in all editions of this text ('43, fig. 488).

Killian ('08) likewise held that the most cranial circular fibers attach to the tendon. Abel ('13) merely confirmed Birmingham's description in detail. Lerche ('36) gave a moderately satisfactory resumé of Laimer's work. Terracol and Nichet ('37) described and beautifully illustrated from dissections the cricoesophageal tendon and the arrangement of muscle fibers originating from it. They described the ten-

don as separating at the caudal border of the cricoid cartilage into three muscular fascicles, two lateral ones which make the lateral longitudinal bands and a median one descending on the ventral surface of the esophagus. Aidar [1] ('43) referred to the "so-called triangular elastic tendon." Brandenburg ('44) called attention to variations in the number of muscle fibers attaching to the tendon.

DISCUSSION

The band dealt with here (fig. 1) gives the striated muscle of the esophagus a fixed point cranially, thus serving as the tendon of origin of the striated muscle. To name this structure specifically would properly emphasize its importance, which is not sufficiently obvious on casual inspection. The term "cricoesophageal tendon" is descriptive and has priority and thus would seem to be the desirable name for inclusion in official anatomical terminology. This term has had little use, occurring only once in the works consulted since Gillette, and that in the paper of Terracol and Nichet. Although the tendon is most obviously the site of origin of the longitudinal fibers, it is well established that the circular fibers also find a fixed attachment in it.

From consideration of the cricoesophageal tendon and the cricopharyngeus muscle it is evident that the usually stated topographical cranial boundary for the esophagus is arbitrary. Muscle fibers of the esophagus originating from the tendon may begin half way up the cricoid lamina; how far, can only be determined after removal of the mucosa. Moreover, as brought out by Laimer and others, the cricopharyngeus muscle often extends so far inferiorly as to have an esophageal part.

Although the majority of our current reference works of gross anatomy illustrate the tendon, it is unusual to find its relationship to the constituents of the esophageal wall clearly depicted or stated. Without this relationship, the significance

[1] I am indebted to Dr. Herta Meyer for translation of this paper.

of the tendon is lost. Cunningham's ('43) diagrammatic figure is excellent, and stands nearly alone in including the relation of the circular muscle to the tendon. The illustrations of Grant ('47), Spalteholz ('33) and Truex-Kellner ('48) show the tendon giving rise only to the longitudinal muscle of the esophagus. The tendon is not specifically named in any of the texts examined except two (Toldt, '28 and Rauber-Kopsch, '29), where it is erroneously labeled "crico-pharyngeal ligament."

SUMMARY

Attention is called to the lack of any designation in official anatomical terminology for the tendon of origin of the striated muscle of the esophagus. The term "cricoesophageal tendon," first used by Gillette in 1872, is recommended as the desirable name for adoption. A brief survey of the literature is given.

LITERATURE CITED

Abel, W. 1913 The arrangement of the longitudinal and circular musculature at the upper end of the oesophagus. J. Anat. and Physiol., *47:* 381–390.

Aidar, O. 1943 Dados sobre a arquitetónica muscular da porção inicial do esofago humano; nota preliminar. Arq. de cir. clin. e exper., *7:* 548–551.

Birmingham, A. 1898 A study of the arrangement of the muscular fibers at the upper end of the oesophagus. J. Anat. and Physiol., *33:* 10–21.

Boyer, M. leBaron 1815 Traité complet d'anatomie, 4th ed., *4:* 312. Migneret, Paris.

Brandenburg, N. B. 1944 Musculature variations of the pharyngoesophageal segment. Laryngoscope, *54:* 136–147.

Cunningham's Textbook of Anatomy 1902 First ed., ed. by D. J. Cunningham. Y. J. Pentland, Edinburgh.

———— 1943 8th ed., ed. by J. C. Brash and E. B. Jamieson. Oxford University Press, Edinburgh.

Gillette 1872 Description et structure de la tunique musculaire de l'oesophage. J. de l'Anat. et de la Physiol., *8:* 617–644.

Grant, J. C. B. 1947 An atlas of anatomy, 2nd ed. Fig. 559. Williams and Wilkins Co., Baltimore.

Gray's Anatomy of the Human Body 1948 25th ed., ed. by C. M. Goss. Lea and Febiger, Philadelphia.

Henle, J. 1866 Handbuch der systematischen Anatomie des Menschen. Vol. 2, Eingeweidelehre. F. Vieweg und Sohn, Braunschweig.

KILLIAN, G. 1908 Ueber den Mund der Speiseröhre. Ztschr. f. Ohrenh., *55:* 1–41.

KOPSCH, F. 1937 Die Nomina anatomica des Jahres 1895 (B.N.A.) nach der Buchstabenreihe geordnet und gegenübergestellt den Nomina anatomica des Jahres 1935 (I.N.A.). Georg Thieme, Leipzig.

LAIMER, E. 1883 Beiträg zur Anatomie des Oesophagus. Med. Jahrbücher, Wien Jahrg., 333–388.

LERCHE, W. 1936 The muscular coat of the esophagus and its defects. J. Thorac. Surg., *6:* 1–19.

LUSCHKA, H. 1862 Die Anatomie des Menschen, vol. 1. Laupp and Siebeck, Tübingen.

RAUBER-KOPSCH'S LEHRBUCH UND ATLAS DER ANATOMIE DES MENSCHEN 1929 13th ed., vol. 4. Fig. 111. Georg Thieme, Leipzig.

SANTORINI, D. 1775 Septemdecim tabulae. Parmae.

SCHMAUSER, F. T. 1866 Observationes de structura et textura universi oesophagi humani. Gustavus Schade, Berolini.

SPALTEHOLZ, W. 1933 Hand atlas of human anatomy. 7th English ed., vol. 3. Fig. 602. J. B. Lippincott Company, Philadelphia.

TERRACOL, J., AND L. NICHET 1937 Le segment pharyngo-oesophagien. Rev. de Laryngol., Otol., Rhinol., *58:* 150–185.

TOLDT, C. 1928 An atlas of human anatomy for students and physicians. 2nd English ed., vol. 2, fig. 708. MacMillan Co., New York.

TRUEX, R. C., AND C. E. KELLNER 1948 Detailed atlas of the head and neck. Fig. 68. Oxford University Press, New York.

NUCLEAR VACUOLES IN SPERMATIDS OF C-57 BLACK MICE AFTER INJECTION OF β-1 NAPHTHYLALANINE [1]

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FIVE FIGURES

INTRODUCTION

During the past year we have been testing compounds which might act as amino acid antagonists against normal and tumor cells in vitro (tissue culture) and in vivo. We hoped that a comparison of the effects of antimetabolites on normal and neoplastic cells, would help to define the differences (if any) between the amino acid metabolism of these cells. In the course of this work, we have found that one of the compounds tested, β-1 naphthylalanine,[2] gives a specific lesion in the spermatids of the mouse.

METHODS AND MATERIALS

The β-1 naphthylalanine was administered as a suspension in 5% gum acacia in isotonic saline. All injections were given intraperitoneally, the volume of material being 0.5 ml. The mice used were 4 month old C-57 black males which carried 5 day old T-241 sarcomas subcutaneously. The LD_{50} (single injection) in these animals is approximately 125 mg/kg. Six

[1] This work has been aided by a grant from the American Cancer Society and by a grant and fellowship from the Division of Research Grants and Fellowships of the U. S. Public Health Service.

[2] We are indebted to Dr. Karl Dittmer of Florida State University for the β-1 naphthylalanine.

mice received 120 mg/kg and 14 received 1 gm/kg. Twenty controls were each given 0.5 ml of the diluent.

The testes were not examined in all animals. Of the 1 gm/kg group, testes were examined of two mice sacrificed 7 hours after injection and of three mice sacrificed 24 hours after injection. Of the 120 mg/kg group, testes were examined of three animals sacrificed 24 hours after injection. Testes from an equal number of controls were also examined. The other tissues studied were liver, kidney, duodenum, thymus, pancreas and sarcoma T-241. The fixatives and staining procedures used were, Bouin's followed by hematoxylin-eosin, Carnoy's followed by hematoxylin-eosin or the Feulgen technique and Regaud's fixative followed by Altmann's aniline-fuchsin stain.

RESULTS

Of the other tissues examined, only the thymus and kidney showed any marked changes. There was considerable chromatin debris from cytolysis of lymphocytes in the thymus at 7 and 24 hours. The kidney had casts in the ascending and collecting tubules and some degeneration of tubule epithelium.

In the testicles, many of the spermatids showed a large vacuole in the nucleus (figs. 1, 3, 4, 5); this was not present in any of the controls and was more frequent in the 24-hour specimens than the 7 hour ones. Significantly, none of the other stages of spermatogenesis were affected. Most of the vacuoles were large, involving at least one-half the nuclear volume, and were in contact with the nucleolus on one side and the nuclear membrane on the other. Very few small vacuoles were seen and there was always only one vacuole to a nucleus.

Examination of the spermatogenic tubules that were sectioned longitudinally showed that the lesion appeared at a fairly specific stage in the development of the spermatid. The very early spermatids that have very small or no acroblast vacuole, have very few nuclear vacuoles. As one follows the spermatogenic wave down the tubule, the lesions become more frequent (fig. 5). Between the stage when the acroblast is fairly well developed and indents the nucleus to the stage

when the acroblast starts to spread down over the nucleus, most of the spermatids have a large nuclear vacuole (fig. 4). The vacuole did not show any preferred orientation towards the acroblast or developing tail. In spermatids containing a very large nuclear vacuole (approximately three-fourths nuclear volume), it occasionally appeared as though the vacuole communicated with the cytoplasm — this was not often seen however.

In the spermatids with a nuclear vacuole, the remainder of the nucleus stained much deeper than the unaffected nuclei. Since there was little increase in nuclear size in the presence of the vacuole, this deeper staining may be due entirely to concentration of the nuclear chromatin in a smaller volume.

DISCUSSION

The interlinked problems of the morphological and functional basis for the formation of this vacuole require some further discussion.

The fact that very few small vacuoles could be found suggests that once vacuole formation is initiated, the growth of the vacuole is very rapid.

If we assume (as seems likely) that the β-1 naphthylalanine acts by interfering with some function in the spermatid, it would seem that this function is restricted to the spermatid nucleus. Furthermore, since the vacuole is not found in any other cell type, this function would be part of the specific processes which differentiate a spermatid from other cells, that is, the processes involved in the maturation of the spermatid.

The similarity of the structure of β-1 naphthylalanine to that of phenylalanine and tryptophane suggests that it may act as an antimetabolite to these compounds. However, Dittmer ('50) has shown that β-1 naphthylalanine reverses the inhibition of growth of E. coli by thienylalanine, the latter being a known phenylalanine antagonist. Dittmer ('50) has also shown that β-1 naphthylalanine fed to rats on a tryptophane deficient diet does not increase the severity of the

tryptophane deficiency (by weight loss criteria). The first observation does indicate that β-1 naphthylalanine can enter into amino acid metabolism although both certainly negate the idea that β-1 naphthylalanine acts as an antimetabolite to either of the above amino acids.

Although we can reach no conclusion as to the specific functions involved in the action of β-1 naphthylalanine on spermatids, the above discussion does highlight a significant concept — that is, a careful study of the morphological abnormalities induced by known antimetabolites in a complex process such as the maturation of the spermatid, may lead us to a more precise formulation of the functional basis of the process.

SUMMARY

1. In C-57 black mice, injected with β-1 naphthylalanine, a large vacuole appears within 7 hours in the spermatid nucleus.

2. This lesion appears after the formation of the acroblast is started.

3. The vacuole shows no preferred orientation in respect to the acroblast or tail.

LITERATURE CITED

DITTMER, K. 1950 The structural bases of some amino acid antagonists and their microbiological properties. Ann. N. Y. Acad. of Sci., *52*, Art. 8, pp. 1274–1301.

PLATE

PLATE 1

EXPLANATION OF FIGURES

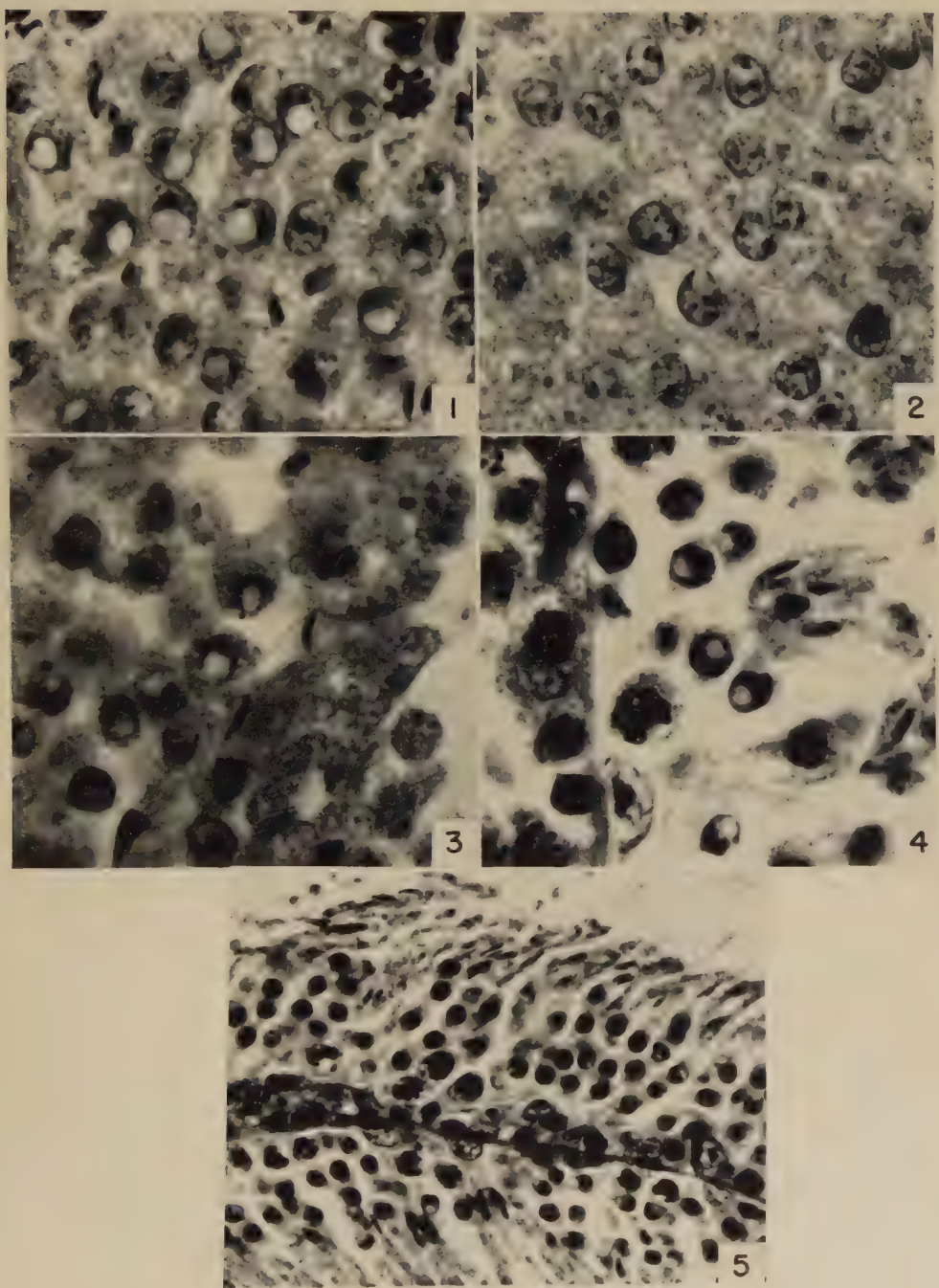
1 Treated, 1 gm/kg β-1 naphthylalanine; sacrificed 24 hours. Carnoy fixation; hematoxylin-eosin. × 1125.

2 Control. Carnoy fixation; hematoxylin eosin. × 1125.

3 Treated, 1 gm/kg β-1 naphthylalanine; sacrificed 24 hours. Carnoy fixation; hematoxylin-eosin. × 1125.

4 Treated, 120 mg/kg β-1 naphthylalanine; sacrificed 24 hours. Showing the relation of the vacuole to the acroblastic indentation of the nucleus. Carnoy fixation; hematoxylin-eosin. × 1125.

5 Treated, 120 mg/kg β-1 naphthylalanine; sacrificed 24 hours. In the upper tubule, the number of nuclei containing a vacuole increases from left to right. Bouin fixation; hematoxylin-eosin. × 500.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RUPTURE OF THE VAGINAL CLOSURE MEMBRANE DURING PREGNANCY IN THE GUINEA PIG [1]

DONALD H. FORD, RICHARD C. WEBSTER [2]
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ONE FIGURE

The generally held opinion that the vaginal closure membrane of the guinea pig is open only at the time of estrus and parturition has, as far as the writers have been able to ascertain, not been questioned since its genesis from the observations of Stockard and Papanicolaou ('19), Kelly and Papanicolaou ('27) and older investigators whose work is reviewed by the latter authors. From time to time during earlier studies of pregnant guinea pigs in our laboratory, openings were seen, particularly between the 20th and 35th days of gestation. Often, however, a small amount of blood was oozing through the opening and the rupture at this time was assumed to be associated with a threatened or actual resorption of one or more fetuses. It was not until recently when a large number of pregnant females were being examined daily for signs of resorption or early abortion that we came to realize that a vaginal opening of variable duration during pregnancy is the rule rather than the exception in the guinea pig. Such being the case, we became interested in ascertaining the incidence of the opening in a sizable group of pregnant animals, the time of its occurence, and any possible relationship to the course of gestation or to the size and condition of the litter.

[1] This investigation was supported in part by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, U. S. Public Health Service and in part by a grant from the Committee for Research in Problems of Sex, National Research Council.

[2] Now Assistant Professor of Anatomy, Indiana University School of Medicine.

MATERIALS AND METHODS

One hundred thirty-three pregnant females for which the time of conception was known were used. Each was examined once daily beginning the 15th day after mating throughout the balance of pregnancy. It is on the 15th day that we routinely begin to examine all females that have mated because rupture of the vaginal membrane and estrus can be expected about this time if the mating was sterile. When rupture and heat do not occur between the 15th and 20th day the female is assumed to be pregnant. Rupture of the membrane however is not always diagnostic of a sterile mating. The vaginas of 6 of the 133 pregnant females opened between the 15th and 18th day following conception.

During the daily examinations the condition of the vaginal membrane was recorded, whether it was intact or ruptured and the extent of any opening. These data yielded information with respect to (1) the day of the first opening for each animal, (2) the day of closure, or, of the final closure when opening and closing occurred several times during gestation, (3) the total days of opening for each animal, and (4) the per cent of animals having ruptured vaginal membranes on each day of the gestation period after the 15th day. At the end of gestation, size and condition of the litter were recorded.

PRESENTATION OF DATA

Observational. The data are summarized in table 1 and figure 1. In only 24 animals did the vaginal membrane remain closed throughout pregnancy. In the 109 females in which rupture was seen, the mean number of days of the opening was 9.64 ± 0.484 (P.E.). The opening was not always confined to a single succession of days, although this happened in 30 animals. In 79 animals there was a period during which days of opening were interspersed with days of closure. In 10 of the 79, intermittent opening and closing occurred throughout most of the pregnancy after the 25th day.

These observations suggest a grouping of animals. In 24 or approximately 18% the vaginal membrane did not rupture

TABLE 1

The time of vaginal opening during pregnancy in 109 guinea pigs

FIRST TRIMESTER			SECOND TRIMESTER			THIRD TRIMESTER		
Day	First opening	First day final closure	Day	First opening	First day final closure	Day	First opening	First day final closure
1			24	15	1	47		4
2			25	13	1	48		1
3			26	16	1	49		5
4			27	11	3	50		3
5			28	10	2	51		2
6			29	3	1	52		
7			30	1	7	53		1
8			31	1	6	54		1
9			32	4	3	55		1
10			33	1	5	56		
11			34		5	57	1	
12			35	1	7	58		2
13			36	1	9	59		1
14			37		4	60		1
15	2		38		3	61		
16	2		39	1	1	62		1
17	1		40	2	1	63		1
18	1		41		5	64		
19	1		42		1	65		1
20	3		43		3	66		
21	2		44		2	67		
22	9		45			68		
23	6		46	1	3	69		
Total	27	0	Total	81	74	Total	1	25

The vaginas of 10 females were open intermittently throughout the second and third trimesters.

during pregnancy. In 30 or 22.5% it opened only once. In 69 or 52% the membrane opened and closed intermittently during much of the pregnancy, but eventually closed until parturition. In 10 or 7.5% of the animals the intermittent opening and closing was characteristic of the terminal two-thirds of the gestation period.

Rupture of the membrane was not without predictability. The first opening was confined for the most part to the end of the first trimester of pregnancy or to the first part of the

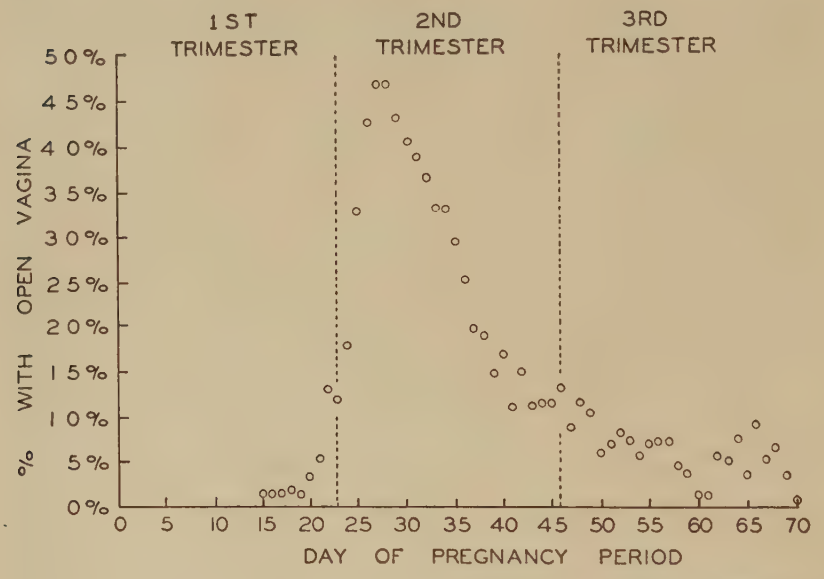

Fig. 1 The per cent of females having open vaginas on each day of pregnancy.

second (table 1). The time of closure was less sharply localized, but in general it occurred during the second trimester. A ruptured membrane during the third trimester was of less frequent occurrence than during the second trimester. In terms of the per cent of pregnant animals showing openings, the peak was at the 26th and 27th days, therefore early in the second trimester (fig. 1). From then on the decrease in the per cent of open vaginas was rapid, although a zero-point was not reached, first, because there

were 10 animals in which opening and closure were intermittent until the end of gestation, and second, because in nine animals rupture of membranes that had been closed during the third trimester or longer occurred one to 4 days before parturition.

The form of the opening is usually not identical with that characteristic of the period of estrus in the non-pregnant female. In non-pregnant estrous animals the membrane disappears from the entire vaginal orifice. In some pregnant females this occurs, but very often the opening is confined to the posterior half or third of the orifice. It is, however, easily visible macroscopically.

Opening of the membrane during pregnancy does not seem to be related to the number of fetuses or offspring. Mean litter-size was 3.66 in the 24 females in which no opening occurred, 3.50 in the 30 females in which the vagina opened only once, 3.26 in the 69 females in which opening and closing were intermittent during approximately all of the second trimester, and 3.20 in the 10 females in which opening and closing were intermittent during the second and third trimesters. The figures form a descending series, but the differences are not sginificant.

There does not seem to be any relationship between resorption, abortion or still-birth, and vaginal membrane rupture. Seven of the 10 females in which opening and closure were intermittent during the second and third trimesters gave birth to living litters of normal size. In the other three females living young were born, but in each litter there was also one still-born fetus. Of the 24 animals at the other extreme, that is, those in which no opening had occurred during pregnancy, the litters were, for the most part, composed of living young with an occasional still-born individual. Two pregnancies, however, terminated abnormally. One female delivered a litter of three dead and two alive prematurely on the 61st day. A second female was found to be moribund on the 68th day and 5 dead fetuses were removed from the uterus. These facts suggest that the ruptured membranes referred

to earlier through which blood was seen to ooze during the resorption of one or more embryos or preceding abortion may have been not more than coincidence. An open orifice during pregnancy is not necessarily indicative of impending resorption or abortion.

Experimental. The frequency with which the vaginal closure membrane ruptures during pregnancy in the guinea pig and particularly the proportion of cases in which opening and subsequent closure are confined to the second trimester of pregnancy suggest that it has some significance for the course of gestation. Any association with litter-size, the premature termination of pregnancy or the condition of the offspring would seem to be excluded by the data summarized above. Two other possibilities remain to be considered. One is that an ovulation takes place early in the second trimester and that rupture of the vaginal membrane at this time is initiated by an ovarian action similar to that which initiated rupture of the membrane about the time of estrus in the non-pregnant female. Examination of three pairs of serially sectioned ovaries removed from pregnant animals immediately after vaginal opening was first detected revealed no evidence of ovarian activity beyond that seen at other times during pregnancy (Dempsey, '37).

The other possibility is that the vaginal opening we have described is associated with the transition from the ovarian to the placental control of pregnancy which occurs in this species (Herrick, '28; Nelson, '34). It seems not unlikely that this transition is made about the beginning of the second trimester and that vaginal membrane rupture at this time might be an expression of a transitory deficiency in available progesterone.

In order to test this suggestion 12 pregnant females were injected with 0.2 I.U. progesterone [3] daily beginning the 15th day after conception and 9 were injected daily with 0.4 I.U. It may be indicative of what is involved that in the 21 animals

[3] Prolution supplied through the courtesy of the Schering Corporation, Bloomfield, New Jersey.

the mean length of the vaginal opening was 5.095 ± 0.844 days compared with 7.900 ± 0.453 days for the 133 untreated females. The mean difference of 2.805 days is not significant at the 5% level with "Student's" t test as modified by Fisher (Hume, '47). The results therefore do not confirm the suggestion that the opening during the second trimester of pregnancy is due to a deficiency of progesterone. Nevertheless, the possibility cannot be excluded. The results may be different when larger amounts of progesterone or some combination of estrogen and progesterone can be used in a more elaborate experimental study.

SUMMARY

In 109 of 133 pregnant guinea pigs, the vaginal membrane opened and closed during pregnancy. The time of the opening was largely confined to the second trimester, the peak being on the 26th and 27th days of the 68- to 69-day gestation period. Rupture of the membrane could not be associated with any abnormality of pregnancy or with the number of fetuses. The hypothesis is advanced that the opening is associated with the transition from the ovarian to the placental control of pregnancy at which time there might be a deficiency of progesterone. When the possibility was tested by injecting progesterone into pregnant females, the duration of the vaginal opening was shortened from an average of 7.9 to 5.1 days.

LITERATURE CITED

Dempsey, E. W. 1937 Follicular growth rate and ovulation after various experimental procedures in the guinea pig. Am. J. Physiol., *120:* 126–132.

Herrick, E. H. 1928 The duration of pregnancy in guinea pigs after removal and also after transplantation of the ovaries. Anat. Rec., *39:* 193–200.

Hume, C. W. 1947 A conspectus of the elements of statistcal analysis. In A. N. Worden, *The U F A W Handbook on the Care and Management of Laboratory Animals.* London.

Kelly, G. L., and G. N. Papanicolaou 1927 The mechanism of the periodical opening and closing of the vaginal orifice in the guinea pig. Am. J. Anat., *40:* 387–411.

NELSON, W. O. 1934 Studies on the physiology of lactation. III. The reciprocal hypophyseal-ovarian relationhship as a factor in the control of lactation. Endocrinology, *18:* 33–46.

STOCKARD, C. R., AND G. N. PAPANICOLAOU 1919 The vaginal closure membrane, copulation, and the vaginal plug in the guinea pig, with further considerations of the oestrous rhythm. Biol. Bull., *37:* 222–245.

A DIVIDED INTRAHEPATIC GALLBLADDER IN A CAT

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SEVEN FIGURES

During one of the laboratory periods in Comparative Anatomy Mr. Richard Lucier, a student, called attention to the peculiar condition of the gallbladder in his cat (fig. 1). The bladder and its ducts were freed from the liver and were found to present an unusual condition which seemed worthy of further study.

A survey of the literature reveals that Boyden ('26) has made the most exhaustive study of gallbladder anomalies and reviewed the previous literature. He traced their probable embryonic origins and recognized three principal types of accessory bladders in the cat. Since 1926 other instances of accessory or otherwise anomalous bladders have been reported in various animals: sheathfish (Gehrke, '33); sea snakes (Bergman, '35); hyrax (Thomson, '38); cat (Gribble, '50); loris (Rau, '28); rhesus monkey (Tittler, '45 and Kirkman, '46) and man (Boyden, '35 and McNamee, '35).

OBSERVATIONS

The right and left bladders in our specimen were separate caudally to about the normal position of the beginning of the cystic duct. It was a *vesica fellea divisa* of the deeply cleft bilobed type (Boyden, '26), and therefore one which had probably developed by a subdivision of the primary cystic diverticulum in the embryo. The left bladder was only slightly larger than the right one. The cystic duct originated at the junction of two hepatic ducts, one of which came from the

lateral edge of the right median lobe and from the entire right lateral lobe; the other from most of the remainder of the liver. A small hepatic, or cysto-hepatic, duct emptied into the cystic duct from the medial edge of the right median and caudate lobes.

The gallbladder normally lies in a deep fossa, the *fossa vesica fellea,* in the right median lobe (fig. 3). In our specimen there was a cleft in the liver at this point which was deeper than normal, but slit-like. This cleft divided the lobe about half way to its base. Figure 1 makes it appear that the two bladders were widely separated, but in fact, the left bladder angled sharply toward the right bladder within the "accessory" median liver lobe in such a way that the rim of liver tissue to the right of the left bladder was not over 5–6 mm deep, and the strip of tissue to the left of the right bladder was not more than 3–4 mm deep. The right and left bladders were situated close to one another along the internal and inferior edges of the cleft. They were covered and held together by a tough sheet of peritoneum which appeared to dip into the space between the two bladders, separating them from one another.

Boyden ('26) stated that the occurrence of accessory bladders is especially common in the cat (1 in 8), although Kirkman ('46) cites personal correspondence from Boyden which indicates that cats in the Minneapolis region have fewer accessory bladders than Boston's cat population! The only gallbladder anomaly reported by Gribble ('50) in approximately 900 specimens which he examined was a single case of its total absence.[1] Of the nearly 2600 specimens examined by Boyden ('26), there were only 26 in which the primary and accessory vesicles were of equal size. He made no mention of bladders in which the tips penetrated the liver tissue, but in a previous paper ('25, p. 157) he shows an intrahepatic bladder associated with the development of a

[1] Dr. Gribble informs me that a second specimen showing complete absence of the gallbladder was found after his manual had gone to press, and that he has noted several cases of completely intrahepatic bladders in the cat.

pancreatic bladder. The condition in which both parts of a divided bladder penetrate the liver tissue was considered rather rare, since it combined two anomalies. Of approximately 200 cats which my students have dissected over the past 5 years, no other specimen has shown a comparable condition, although several have shown varying degrees of intrahepatic location of the otherwise normal single bladder (figs. 4–7). In most of these specimens, the cleft marking the location of the fossa vesica fellea was reduced or absent. In one specimen the caudal margin of the right median lobe was entire, with no hint whatsoever of the normal position of the fossa (fig. 7). From this it would seem that a reduction of the fossa might be associated with the intrahepatic location of the gallbladder. In another specimen there was a slight outpouching on the side of the primary bladder, but the bladder lay in a deep excavation on the inferior surface of the liver, and there was a cleft in the right median lobe which was even more extensive than in the one described above (fig. 6).

DISCUSSION

The relation of gallbladder anomalies to the appearance of the liver lobes seems to have received little consideration on the part of previous authors. In the small series available it appeared that when the bladder was situated in an intrahepatic position, the fossa in which it normally lay became more or less filled up with liver tissue (figs. 3–5 and 7). This is not surprising, since plasticity is one of the liver's well known attributes. The fact that there was a deep cleft of the liver lobe associated with a doubling of one gallbladder which was in turn combined with the intrahepatic location of the bladders (fig. 1) does not seem to fit with the idea that the liver fills in the space when the bladder develops in an intrahepatic situation. One is tempted to assume that the "force" which causes the division of the gallbladder is sufficiently extensive, and of sufficient duration, to affect the liver also. Boyden ('25, p. 171; and '26, p. 187) has shown that the liver diverges laterally at a

stage (6 mm) coincident with the abnormal splitting of the cystic diverticulum. Thus, it may be that the growth of the bladders between the diverging lobes of the liver provides sufficient obstruction to prevent the fusion of the medial walls of the fossa, with the result that a deep cleft persists, as shown in figures 1 and 6. Since the series available is so limited, however, it may be that the relationship of cleft to divided bladder and to intrahepatic situation suggested above is a mere chance arrangement. Until further data are available, either interpretation is possible.

ACKNOWLEDGMENTS

Sincere thanks are due Dr. Edward A. Boyden for his helpful suggestions and encouragment after reading the manuscript. Dr. Lloyd R. Gribble kindly answered questions regarding anomalies reported by him, and showed interest in this peculiar anomaly.

LITERATURE CITED

Bergman, R. A. M. 1935 Le système excrétur du pancrease et de la vesicule biliaire chez les serpentes de mer. Acta Brevia Neerland., *5:* 155–157.

Boyden, E. A. 1925 The problem of the pancreatic bladder. Am. J. Anat., *35:* 151–184.

———— 1926 The accessory gallbladder. An embryological and comparative study of aberrant biliary vesicles occurring in man and the domestic animals. Am. J. Anat., *38:* 177–231.

———— 1935 The "phrygian cap" in cholecystography. A congenital anomaly of the gallbladder. Am. J. Roent. and Rad. Ther., *33:* 589–602.

Gehrke, P. J. 1933 Über das Auftreten doppelter Gallenblasen beim Wels (Siluris glanis L.). Anat. Anz., *77:* 123–125.

Gribble, L. R. 1950 Comparative anatomy laboratory manual. Blakiston Co., Phila. xii + 231 pp.

Kirkman, H. 1946 A simian, deeply cleft, bilobed gallbladder with "phrygian cap." Anat. Rec., *95:* 423–444.

McNamee, E. P. 1935 Intrahepatic gallbladder. Am. J. Roent. and Rad. Ther., *33:* 603–610.

Rau, A. Subba 1928 Notes on a case of triplicate gallbladder in *Loris lydekkerianus* Cabr. Half-yearly J. Mysore Univ., *2:* 10–19.

Thomson, S. C. 1938 The extrahepatic biliary tract of the hyrax. Anat. Rec., *72:* 445–449.

Tittler, I. A. 1945 Two cases of accessory gallbladder in the rhesus monkey, *Macaca mulatta.* Anat. Rec., *91:* 257–260.

PLATE

PLATE 1

EXPLANATION OF FIGURES

1 Bilobed gallbladder, with tip of each lobe completely surrounded by liver tissue. Note also fissure at normal position of fossa vesica fellea (cf. fig. 3).

2 Bladders and ducts of specimen shown in figure 1.

3 "Normal" appearance of right median liver lobe and gallbladder, which lies in a deep fossa vesica fellea.

4–7 Varying degrees of reduction of the fossa vesica fellea associated with intrahepatic or lobed gallbladders.

ABBREVIATIONS

AV, ampulla of Vater; C, cystic duct; CL, caudate lobe; D, duodenum; DC, ductus choledochus; DP, pancreatic duct; FVF, fossa vesica fellea; G, gallbladder; RH, right hepatic duct; L, left liver lobe; LG, left lobe of gallbladder; LH, left hepatic duct; L(L), lateral surface of left liver lobe; L(M), medial surface of left liver lobe; M, left median liver lobe; RG, right lobe of gallbladder; RL, right lateral liver lobe; RM, right median liver lobe.

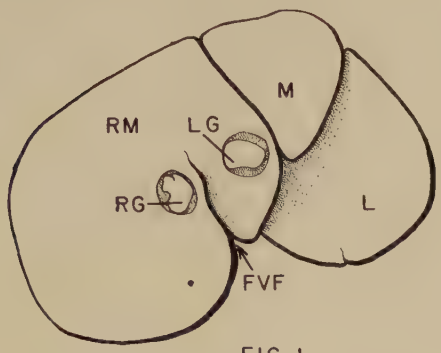

FIG. 1

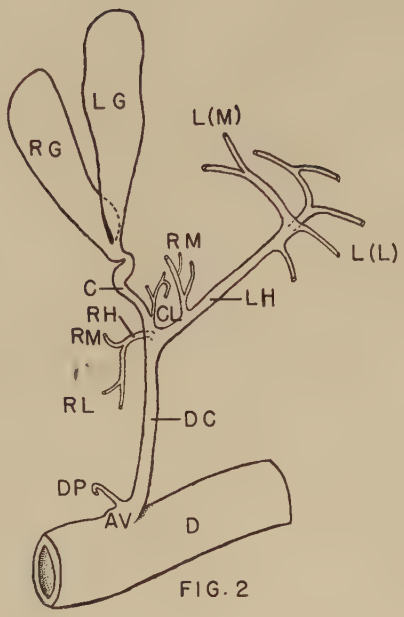

FIG. 2

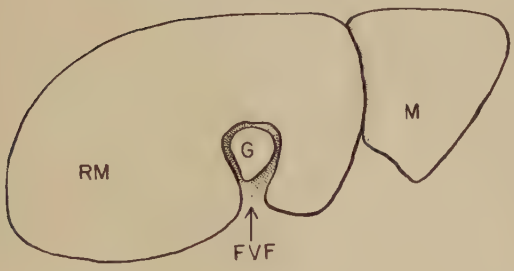

FIG. 3

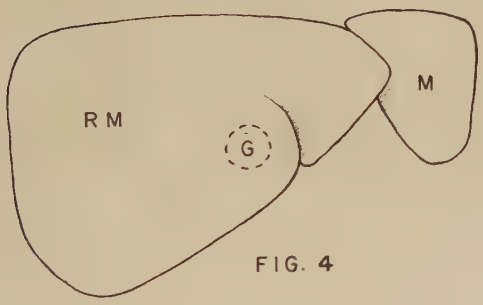

FIG. 4

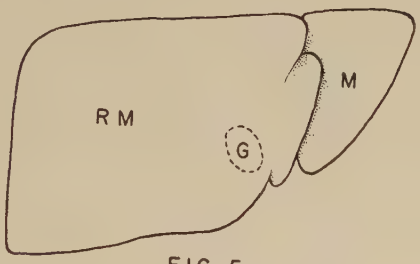

FIG. 5

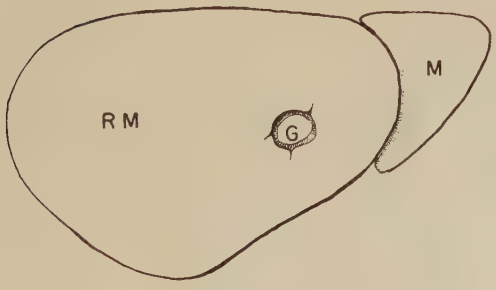

FIG. 7

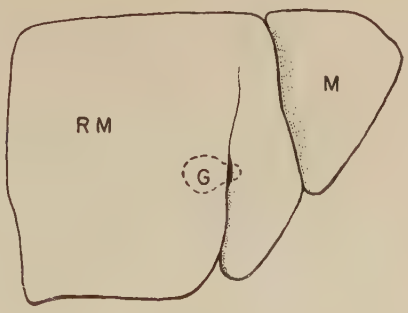

FIG. 6

THE MATURITY OF PERIPHERAL NERVES AT THE TIME OF INJURY AS A FACTOR IN NERVE REGENERATION [1]

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ELEVEN FIGURES

Every peripheral nerve is composed of fibers of various sizes. A classification of mature fibers according to size reveals a definite frequency pattern for a given nerve, conveniently referred to as the "fiber spectrum." Since the functions of nerves are each subservient to fibers of a particular range of size, the significance of the "fiber spectrum" is obvious. Physiological properties (conduction velocity, threshold) can now be correlated with fiber size (Erlanger and Gasser, '37).

Interruption of peripheral nerve fibers causes the isolated distal processes to degenerate. Nerve sprouts from the proximal stump grow across the site of the lesion and into the peripheral segment. Regenerating fibers continue to grow until they establish connections with end organs. After this occurs, they increase in diameter and mature. As an aftermath of degenerative and regenerative processes, nerve fibers are generally of reduced size. Often they are also greatly reduced in number. The resulting abnormal fiber

[1] This research was supported in part by grants-in-aid from the United States Navy, Department for Dental Research and the Penrose Fund of the American Philosophical Society.

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spectrum is attended with gross functional abnormalities which are most striking in the motor components responsible for fine muscle coordination. Berry, Grundfest and Hinsey ('44) studied regenerated nerves oscillographically and demonstrated abnormalities in action potentials, threshold, and conduction velocities. Diameters of regenerated peripheral nerve fibers have been histologicallly investigated (Weiss, '37; Davenport, Chor and Dolkart, '37; Holmes and Young, '42; Gutmann and Sanders, '43; Sanders and Young, '44; Simpson and Young, '45; Aitken, Sharman and Young, '47). Regeneration is complete only if the number and size of fibers are comparable to those normally present.

Restoration of size and number of fibers in the regeneration of a given peripheral nerve has been shown to depend on several factors. With nerve damage at proximal levels, retrograde degeneration may involve destruction of cells of origin (Ranson, '13; Romanes, '46). This destruction is very severe in very young animals (Gudden, 1872; Romanes, '46). The number and size of fibers of the proximal stump determines in part the number and size of regenerated fibers (Sanders and Young, '44; Simpson and Young, '45). Connective tissue intrusions at the site of the lesions may impede the growth of fibers into the distal stump (Weiss, '44). Degenerated detritus may occlude the Schwann tubes of the distal stump (Weiss, '44). The number and size of Schwann tubes may be inadequate to accomodate outgrowing fibers (Holmes and Young, '42; Sanders and Young, '44; Simpson and Young, '45). Proper terminal connections are essential for full progress to maturity (Litwiller, '38; Weiss, Edds and Cavanaugh, '45; Aitken, Sharman and Young, '47; Edds, '49). It has been demonstrated conclusively that endoneural tubes of peripheral degenerated stumps shrink before they are again occupied by nerve processes and thus exert a restrictive action on fiber size (Holmes and Young, '42; Sanders and Young, '44). These factors and others are considered in extensive reviews (Bethe, '03; Huber, 1895; Ranson, '12; Cajal, '28; Young, '42; Weiss, '44; Edds, '46).

Dunn ('12) demonstrated that the number and size of myelinated peripheral nerve fibers of rats increase from 8 days until maturity. Hursh ('39) has followed the properties of growing nerve fibers oscillographically in cats ranging in age from a few days to three months. He found an increase of maximal velocities in proportion to leg length. Measurements of diameters of sciatic and common peroneal nerves of rats fixed in formalin show that these nerves more than double their original diameters during the 10 days following birth and have increased 3 to 4 times their birth diameters at maturity (see also Ide, '29). Peripheral nerves of newborn rats are composed of many small unmyelinated and myelinated fibers (Dunn, '12). Connective tissue elements are poorly developed and endoneural tubes are small.

Since the number of myelinated fibers and their size gradually increase from the time of birth until animals are full grown, it is reasonable to assume that the maturity of nerve fibers during this interval would be an important factor in regeneration. To explore this possibility, the left sciatic nerve of rats of varying age was crushed and the progress of regeneration evaluated.

METHOD

Fifty rats varying in age from 1–57 days were used experimentally. Animals of 1–4 days were anesthetized by refrigeration (placed on blocks of ice until motion ceased). Older animals were anesthetized with nembutal. A longitudinal incision was made over the left gluteal region extending between the ischial tuberosity and greater trochanter. Skin and gluteal muscles were retracted and the sciatic nerve exposed. By using the tips of watch-maker's forceps a crush of approximately a millimeter was made below the gluteal branches and at the level of the ischial tuberosity and greater trochanter. Following nerve crush the skin was sutured, the wound area painted with tincture of iodine and covered with 1% celloidin.

Animals of two weeks or less require additional care. If returned to the cage immediately after the operation, parent

rats attempt to clean the wound, causing bleeding and destroy their young. This may be avoided by waiting 5–6 hours before returning animals to cages.

Most animals reported in this study were sacrificed 100 days post-operatively. A few test cases were sacrificed at 40 and 280 days. Three normal mature animals were used to obtain control material (table 1). Lumbosacral spinal cords were removed from a few representative experimental animals to observe retrograde changes in motor cells of the sciatic. Left sciatic nerves were exposed and pieces approximately 1 cm long were removed above and below the site of the lesion. Similar levels were removed from the contralateral side. This material was fixed in 1% osmic acid. The site of the crush was prepared with protargol techniques and sectioned longitudinallly.

The common peroneal is relatively free of branches in the lower half of its course in the popliteal fossa and of uniform diameter and fiber number (Greenman, '13). Cross sections at this level were therefore selected for area measurements, fiber diameter measurements and fiber counts. Right and left common peroneals were exposed. A centimeter piece was removed from each at the same level, stretched to its initial length on a small piece of cardboard, fixed in 1% osmic acid, and sectioned at 5 μ. Results obtained from studies of the experimental nerve were compared with contralateral controls and used to evaluate the progress of regeneration (tables 1, 2, 3).

After removal of nerve material, right and left legs were amputated at the knee joint and weighed. Crushing the sciatic nerve interrupts the nerve supply necessary for the contraction and trophic control of muscles below the knee joint. Weights of this portion were used as a general indication of atrophy in each age group (table 2).

Cross sections of osmic fixed material at 5 μ were projected at 280 × on millimeter paper. Fiber counts were made of the experimental common peroneal and the contralateral normal. Sample areas from the projections were used to de-

TABLE 1

Leg weights; cross-sectional areas, × (280)², fiber numbers and fiber densities of right and left common peroneal nerves of three mature rats

ANIMAL NUMBER	WEIGHT	LEG WEIGHT		CROSS SECTION. [CM² × (280)²]					FIBER NUMBER					FIBER DENSITY		
		Right leg	Left leg	Right nerve	Av.	Left nerve	Av.	Δ%	Right nerve	Av.	Left nerve	Av.	Δ%	Right nerve	Left nerve	L/R
183	255	6.00	6.02	238.2 246.3 241.2 241.7 244.8	242.4	208.7 212.9 212.9 214.6 223.2	214.4	88.5	1960 2048 1934 1972 1995	1982	1980 2114 2048 1998 1930	2014	101.8	8.19	9.41	1.15
184	256	6.10	6.00	231.3 236.0 238.7 234.0 238.4	235.7	248.3 244.0 258.0 245.1 245.4	248.2	105.3	1793 1899 1829 1861 1932	1863	1872 1894 2004 1863 1910	1908	102.1	7.89	7.69	.98
185	230	5.75	5.86	209.9 209.4 202.5 206.3 211.0	207.8	209.4 206.4 198.7 205.0 212.8	206.4	99.8	1859 1835 1802 1896 1850	1853	1820 1880 1830 1800 1941	1838	99.2	8.91	8.92	1.00
Av.	247	5.95	5.96		228.6		223.0	97.5		1899		1920	101.2	8.33	8.67	1.04

TABLE 2

Age and weight of experimental animals at time of operation; leg weight at time of sacrifice

ANIMAL NUMBER	AGE IN DAYS		GAIN IN WEIGHT (GM)						LEG WEIGHT (GM) AT SACRIFICE					
	At oper.	At sacrif.	At oper.	Av.	At sacrif.	Av.	Sac. op.	Av.	Right leg	Av.	Left leg	Av.	Δ%	Av.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	4	108	7.0		176.0		25.1		5.6		3.9		31.6	
2	4	108	6.5		264.0		40.7		6.0		4.1		32.5	
3	4	108	8.0	7.6	270.0	251.0	33.8	33.0	7.0	6.6	4.8	4.3	31.4	35.0
4	4	108	9.0		293.0		32.6		7.8		4.3		44.5	
5	10	110	16.5		224.0		13.6		5.1		4.1		20.0	
6	10	110	15.0		248.0		16.5		5.4		4.5		16.0	
7	11	111	16.0	15.6	266.0	231.0	16.6	14.8	7.0	6.0	5.9	5.0	15.7	17.2
8	11	111	15.0		186.0		12.4		6.5		5.4		16.9	
9	14	114	18.0		215.0		11.4		6.0		5.5		8.3	
10	14	114	19.5		229.0		11.2		7.1		6.0		15.5	
11	14	114	17.9	18.3	227.0	211.0	12.7	11.3	6.3	6.0	5.4	5.3	14.3	12.3
12	14	114	19.0		239.0		12.6		6.5		6.1		5.4	
13	14	114	17.0		145.0		8.5		4.2		3.5		17.9	
14	21	121	40.0	40.0	285.0	285.0	7.2	7.2	6.9	6.9	6.3	6.3	9.0	9.0
15	27	129	58.0		183.0		3.2		4.6		4.2		8.3	
16	27	129	63.0	55.0	173.0	205.0	2.8	4.0	4.5	4.6	4.3	4.2	4.5	6.4
17	28	129	44.0		258.0		5.9		*		*			
18	33	133	62.0		167.0		2.7		8.0		7.1		11.3	
19	33	133	67.0	65.0	173.0	170.0	2.6	2.7	6.7	7.3	6.2	6.7	7.5	9.4
20	42	142	96.0		275.0		2.9		8.5		8.0		5.9	
21	44	142	92.0		288.0		3.1		7.3		6.5		10.3	
22	44	144	83.0	87.0	280.0	277.0	3.4	3.2	6.8	7.5	6.3	6.9	7.5	7.9
23	44	144	78.0		268.0		3.4		*		*			
24	57	157	112.0		230.0		2.1		5.4		5.3		3.0	
25	57	157	95.0	96.0	263.0	234.0	2.8	2.5	7.2	5.9	6.8	5.7	5.6	2.9
26	57	157	81.0		208.0		2.6		5.1		5.1		0.0	
Av.	25	125		48.1		233.0		9.8		6.4		5.6		12.5

termine the size of medullated fibers (fig. 1). At this magnification it is impossible to measure and classify accurately the fibers of 4 μ or less. Because of these shortcomings, the histograms (fig. 1) must be considered as giving only a general picture of frequency distribution of fiber size. A few representative sections were photographed at 400 ×. Fiber counts were made at this level to check the accuracy of counts made at 280 ×.

Considerable variations in cross sectional areas of osmic fixed materials occur. This is due to differences in shrinkage at the time of fixation, to variation of angles at sectioning,

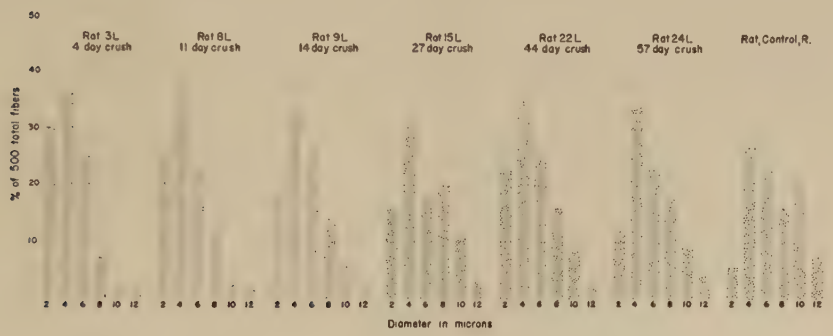


Fig. 1 Histograms of distribution of fiber sizes.

and variations in the stretching of paraffin sections. Calculations of densities are unreliable for given areas (table 3) and must be considered in groups. Shrinkage of material fixed in 95% ammoniated alcohol for the protargol technique was more severe. Cross sections of this material were 30–40% less in area than similar material fixed in osmic acid.

RESULTS

Regeneration studies of a peripheral nerve such as the sciatic require a preliminary examination of this nerve and its larger divisions in normal animals. Three rats were used for this purpose. Measurements of diameters of the sciatic and its larger branches at corresponding levels on the right and left

TABLE 3

Cross-sectional areas and number of myelinated fibers in the common peroneal nerve following sciatic nerve crush in rats of different ages

ANIMAL NUMBER	AGE AT OPERATION	CROSS SECTION, [CM² × (280)²]						FIBER NUMBER						FIBER DENSITY					
		Right nerve	Av.	Left nerve	Av.	Δ%	Av.	Right nerve	Av.	Left nerve	Av.	Δ%	Av.	Right nerve	Av.	Left nerve	Av.	L/R	Av.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	4	196.6		66.4		33.9		1933		1131		58.2		9.9		17.0		1.72	
2	4	181.9		60.8		33.4		1848		1232		66.7		10.2		20.2		1.99	
3	4	178.0	188.5	90.3	70.9	50.7	37.1	1980	1875	1780	1428	89.9	76.2	11.1	10.0	19.8	20.2	1.78	2.04
4	4	197.4		66.4		33.7		1740		1570		90.0		8.9		23.8		2.67	
5	10	182.5		127.5		69.8		1860		1679		90.3		10.2		13.1		1.28	
6	10	182.8		126.7		69.0		1772		1764		99.6		9.7		13.9		1.43	
7	11	230.0	205.2	129.1	127.4	56.1	62.7	1880	1818	1952	1894	105.4	104.8	8.2	9.0	14.1	14.6	1.72	1.67
8	11	225.8		126.0		55.8		1759		2180		123.9		7 8		17.3		2.23	
9	14	244.5		183.6		74.9		1803		1952		108.1		7.3		10.5		1.44	
10	14	190.2		129.0		67.9		1726		1465		84.6		9.1		11.3		1.25	
11	14	237.4	211.1	160.3	151.3	67.6	71.6	1850	1855	1799	1678	96.9	90.5	7.9	8.9	11.2	11.1	1.43	1.27
12	14	200.9		148.4		73.8		2058		1649		80.2		10.2		11.1		1.09	
13	14	182.5		135.5		74.0		1840		1526		82.5		10.0		11.2		1.12	
14	21	206.4	206.4	170.6	170.6	82.8	82.8	1702	1702	1651	1651	97.0	97.0	8.3	8.3	9.7	9.7	1.17	1.17
15	27	180.6		148.3		82.4		1820		1990		109.3		10.8		13.4		1.24	
16	27	158.7	183.0	125.8	154.4	81.0	84.6	1700	1769	1912	1962	112.5	110.9	10.7	10.0	15.2	13.0	1.42	1.29
17	28	208.7		189.1		90.5		1787		1983		110.9		8.6		10.5		1.22	
18	33	227.0		172.5		76.0		2008		2113		105.2		8.8		12.2		1.39	
19	33	182.5	204.8	126.7	149.6	69.0	72.5	1696	1852	1768	1941	104.2	104.7	9.3	9.1	13.9	13.1	1.50	1.45
20	42	234.8		172.0		73.3		1858		2003		107.1		7.9		11.6		1.46	
21	44	238.7		160.8		67.4		1784		1739		97.5		7.5		10.8		1.44	
22	44	248.3	235.0	182.3	178.1	77.6	77.1	1952	1883	1851	1931	94.9	102.1	7.8	8.0	10.2	10.7	1.30	1.34
23	44	218.0		197.1		90.0		1938		2130		109.0		8.9		10.3		1.15	
24	57	238.9		198.9		83.8		2108		2200		104.3		8.9		11.1		1.25	
25	57	193.5	216.9	179.3	179.4	92.4	83.2	1800	1892	1978	2082	109.9	110.3	9.3	8.8	11.0	11.7	1.19	1.34
26	57	218.3		159.9		73.4		1769		2069		116.8		8.1		12.9		1.59	
Av.			206.3		147.1		71.5		1831		1821		99.6		9.0		13.0		1.45

sides show a high degree of bilateral symmetry. For further evidence common peroneal nerves were removed from the lower half of their course in the popliteal fossa, fixed in osmic and sectioned at 5 μ. For studies of cross-sectional areas and fiber counts, five sections were selected from each nerve at approximately equal distances apart. This portion of the common peroneal was found to be very uniform throughout its length and the mean differences in area and fiber number of right and left sides for three cases were only 2.5 and 1.2% respectively (table 1, see also Greenman, '13). Leg weights (amputated at the knee joint) were also about equal on the two sides (table 1).

Left sciatic nerves were crushed at the level of the sciatic tuberosity and greater trochanter. Diameters of the sciatic nerve at this site were measured in a series of animals preserved in 10% formalin. Measurements were made in situ at 1, 4, 7, 10, 14, 21 and 28 days and in adults; averages given in millimeters in the same order: 0.40, 0.61, 0.72, 0.81, 0.93, 1.00, 1.10, 1.50. These figures are an indication of the maturity of this nerve at the time of nerve crush (table 1, 2; see also Dunn, '12; Ide, '29).

Examination of sicatic nerves at sacrifice gave no evidence of neuromas at the site of the crush. Longitudinal sections stained with protargol techniques, except for some constriction in diameter, show an orderly arrangement of nerve fibers bridging the gap. Cross sections at 5 mm or more above the lesion show myelinated fibers which on cursory examination correspond in size and number to the contralateral control. Below the site of the nerve crush cross sections show nerve fascicles which are reduced in area and in the size of myelinated fibers. This deficiency is highest in the youngest animals (table 3). This characteristic reduction in area and size of medullated fibers below the site of the nerve crush can be followed through the entire regenerated sciatic and its main branches. Because of the uniformity, it was found convenient to use the common peroneal as material to evaluate regeneration.

In the 4 day series, sacrificed 100 days after sciatic nerve crush, leg atrophy was grossly visible and within the range of 31.4–44.5%; average 35% (table 2, cols. 13, 14). This atrophy is for the most part confined to the musculature. Bones are also definitely smaller. Animals had functional use of the extremities. Nevertheless, the sciatic nerve below the site of the crush was much smaller, and common peroneals varied from 33.4–50.7% (av. 37.1) of the cross-sectional areas of contralateral controls. This reduction in area is associated with an average loss of 23.8% in nerve fibers (table 3, col. 12); the average density of nerve fibers was 20.2 as compared with 10.0 for controls (table 3, cols. 16, 14). The fiber spectrum for this 4 day series gives a peak of distribution around the 4 μ group. Larger fibers characteristically present in control nerves are missing (figs. 1–3).

It is important to remember that the sciatic nerve normally more than doubles its diameter from the time of nerve crush at 4 days to maturity; also, that there has been an average increase of 33 times in body weight during the 100 days after the operation (table 2, col. 8). This is evidence of a rapid growth rate during this interval. An interference with growth processes of a nerve as with a lesion causes severe deficiencies.

Leg atrophy as a result of nerve crush can also be observed in the 10–11-day series and in some of the 14-day animals: leg weights were reduced 15.7–20.0% (av. 17.2) and 5.4–17.9% (av. 12.3) respectively (table 2, col. 14). Cross-sectional areas of regenerated common peroneals averaged 62.7 and 71.6% of contralateral controls (table 3, col. 6).

Six of 9 nerves from 10–14 day group gave a reduction in medullated fibers; three an increase above contralateral controls (table 3, cols. 11, 12). Fiber densities of the 10–11 and 14 day series averaged 14.6 and 11.1 respectively as compared to 9.0 and 8.9 in control nerves. The fiber spectrum as in the 4 day series shows a peak of distribution around 4 μ (figs. 1–5). However, there are more of the larger fibers in the 8–12 μ range. During the post-operative interval for

the 10–11 day and 14 day series, the mean increase in body weight was 14.8 and 11.3 times the weight at operation (table 2, col. 8). Sciatic nerves are of the order of 57 and 66% respectively of their full diameter at maturity. Since animals are larger and the peripheral nerves more mature, the consequences of sciatic nerve lesions are not as devastating as in the 4 day group.

An examination of data obtained from animals in which sciatic nerves were crushed at 21–57 days (tables 2, 3) will show data which belong within a similar range of variability. Leg atrophy was never grossly visible; leg weights gave a mean reduction of 2.9–9.4% (table 2, col. 14). Cross-sectional areas of regenerated common peroneals vary from 72.5–84.6% (av. 80%) of contralateral controls (table 3, col. 6). The number of regenerated medullated fibers for this entire group (21–57 day) averaged 5% greater than control nerves (table 3, col. 12). There is a definite increase in the larger regenerated fibers (figs. 1, 6–11) as compared with the 4–14 day experimental animals. Sciatic nerves at the time of crushing were 1.0–1.2 mm in diameter as compared to 1.4–1.6 mm for adult rats. During the post-operative interval of 100 days for the 21–57 day animals the increase in body weight varied from 2.5–7.2 times the weight at operation (table 2, col. 8).

DISCUSSION

To explain the difference in the progress of nerve regeneration and the associated atrophy in the above mentioned two groups of animals, 4–14 days and 21–57 days, it is necessary to consider the factors which influence nerve regeneration: (1) the cells of origin, (2) the proximal stump, (3) the nature of the lesion, (4) the maturity and condition of the distal stump, and (5) terminal connections.

Cursory inspections of spinal cord levels which give origin to the sciatic nerve, except for nerve crush experiments in the 4 days rats, gave little evidence of destructive retrograde changes. In the 4 days animals, from counts made of repre-

sentative sections, the motor cell loss was within the range of 8–20%. There is abundant evidence that nerve cells undergo rapid and complete degeneration from peripheral nerve damage in young animals (Gudden, 1872; Mayser, 1877; Ranson, '06; Brodal, '40; Romanes, '46). Although no frank evidence was observed of cell destruction in the 10–14 day sciatic nerve crush experiments, it may be possible to establish a slight loss with careful enumeration. No loss was observed in experimental rats of 21–57 day groups. This is in agreement with previous observations. Adult animals (frogs, rabbits, chickens, cats) show a prolonged period of chromatolysis and an increased acid phosphatase in cells of origin as a result of severe damage to the sciatic at the same level as in our present experiments, but no evidnce of cell loss was observed (Bueker, Meyers, Solnitzky, '49). The greater reduction in cross-sectional areas and in myelinated fibers observed in the regenerated common peroneal of nerve crush experiments in the 4 day rat can only in part be accounted for by the cell loss.

Gutmann and Sanders ('43) have shown that a rather complete regeneration of peripheral nerve occurs in adult animals after a nerve crush of a few millimeters. In our experiments the site of the crush was kept at a minimum, and regenerated fibers had an orderly longitudinal arrangement across the gap. We obtained a high degree of regeneration in 21–57 day animals and we agree with Gutmann and Sanders ('43) that there is evidence of restoration of a bimodal fiber spectrum which could be observed in a few cases which were kept 240 days post-operatively. However, in our best experiments medullated fibers never approach the contralateral nerve in size.

Terminal connections were not examined. Functions of affected extremities at the time of sacrifice gave indirect evidence of a high degree of regenerated connection. This was true also in the 4–14 day rats where considerable muscle atrophy was observed (table 2). While no statement is made of limb atrophy (Romanes, '46), excellent functional regen-

eration was observed in newborn mice following nerve crush which was associated with a motor cell loss of 40–50%.

The maturity of peripheral nerves at the time of damage seems to us the most important factor in explaining the greater deficiency of regeneration in younger animals. In the 4–14 day group the sciatic nerve has a diameter at the time of nerve crush within the range of 0.4–0.6 mm as compared with 1.5 mm in adults. Most of the nerve fibers are small and poorly myelinated (see Langworthy, '33). Medullated fibers in the ventral root of the second cervical nerve were observed in rats varying in age from 7–640 days (Dunn, '12). The statement is made that "during the period of rapid growth from the 7th to the 36th day, there is a parallel increase of the number of medullated nerve fibers." Since this condition was observed at the level of the second cervical, it is reasonable to expect a lower degree of myelination in caudal peripheral nerves which form the sciatic.

Small myelinated and unmyelinated fibers are covered with endoneural tubes of corresponding size. Interruption of a peripheral nerve during this period of immaturity and the degeneration of the distal segment will check the growth rate and result in distal endoneural tubes which are inadequate to accommodate regenerating fibers of sufficient size to be comparable with the normal nerve. From our data it seems that the condition of immaturity may be a serious limiting factor for regeneration during the first three weeks of life in rats (table 3). During the 4th week myelination has progressed sufficiently to produce endoneural tubes adequate in size and number to allow for a high degree of regeneration as found in the 21–59 day groups.

Crushing the sciatic causes the distal segment to degenerate and the endoneural tubes to fill with Schwann cells. During the interval of degeneration and regeneration the normal growth increment of this portion will be lost. According to Gutmann, Gutmann, Medawar and Young ('42) nerves grow across the site of a nerve crush in about 5 days; and below a crush at the rate of 5 mm a day. To grow the length of the

degenerated segment of 15–20 mm in a 4–10 day rat a nerve would require a total of 8–10 days. During the 8–10 day interval the contralateral control nerve will have increased .61 mm to .81 mm in diameter or .292 to .515 mm^2 in area; an increase of 76% in area. Absence of this growth increment in the regenerating segment would go far in explaining the loss of 63% in cross-sectional area of the regenerating common peroneal (table 3, col. 6). It would also account for the permanently reduced endoneural tubes which exert a restrictive action on regenerating fibers (for restrictive action of endoneural tubes see Nageotte and Guyon, '18; Holmes and Young, '42; Sanders and Young, '44; Simpson and Young, '45).

As age increases the growth increment of a control nerve, during the interval of degeneration and regeneration of the crushed nerve, becomes less. In the 10–11 day experimental animals the cross-sectional areas of the experimental common peroneal were reduced 37%, while in the 14 day group it was 28% (table 3, col. 6). In older animals, 21–57 day nerve crush experiments the reduction will average approximately 20% (table 3, col. 6).

We do not completely agree with Gutman and Sanders ('43) that nerves are completely restored after nerve crush. In their experiments, however, adult rabbits were used and 300 days were allowed for nerve regeneration. Most of our animals were sacrificed at 100 days and they were not full grown. There is also the possibility that nerve regeneration may be different in the rat. However, in a few test animals sacrificed 280 days after nerve crush the total cross-sectional areas are less than in the contralateral nerve; the average size of medullated fibers is less. There is a definitive bimodal distribution of fiber size, but it does not correspond to the fiber spectrum of the normal nerve. In young animals the shrinkage of endoneural tubes has a lasting effect on the maturation of medullated fibers. This is in agreement with the finding of Holmes and Young ('42) in which considerable shrinkage was observed in the endoneural tubes of the distal

stump, exerting a permanent restrictive action on fiber maturation.

SUMMARY

The purpose of this investigation was to study maturity as a factor in nerve regeneration. Fifty rats varying in age from 4 to 57 days were used as experimental animals. Left sciatic nerves were crushed at the level of the greater trochanter and ischial tuberosity. Most animals were sacrificed 100 days after the operation. Nerve material was prepared with the osmic and protargol techniques and sectioned at 5 μ. A few test animals were sacrificed at 40 and 280 days. The observations which were made are as follows: (1) Leg atrophy 100 days after nerve crush in 4–14 day animals varied from 16–45%. Cross-sectional areas of the regenerated nerve at the level of the common peroneals were reduced 28–64% as compared with the contralateral control. The number of medullated fibers are generally less than in the control. A bimodal distribution of fibers in the regenerated nerve is missing. Most of the fibers are arranged around a peak of distribution of 4 μ. (2) Leg atrophy in 21–57 day animals varied from 3–10%. Cross sectional areas of the regenerated nerve at the level of the common peroneals varied in reduction from 15–27%. The number of regenerated medullated fibers exceeds that of the control nerves. As in the 4–14 day group the peak of fiber distribution is arranged around the 4 μ group. However, there is a definitive increase in the number of larger fibers within this older group. (3) The increment of growth which should occur in a given nerve of a rapidly growing animal is abolished during the degenerative and regenerative interval as a result of the nerve crush. The peripheral stump is therefore composed of permanently reduced endoneural tubes which exert a lasting restrictive action on the maturation of medullated fibers. Cross-sectional areas of regenerated nerves are reduced to such degree in the 4–14 day rat that the number of medullated nerve fibers would generally be less than contralateral nerves.

LITERATURE CITED

AITKEN, J. T., M. SHARMAN AND J. Z. YOUNG 1947 Maturation of regenerating nerve fibers with various peripheral connexions. J. Anat., *81:* 1–23.

BERRY, C. M., H. GRUNDFEST AND J. H. HINSEY 1944 The electrical activity of regenerating nerves of the cat. J. Neurophysiol., *7:* 103–115.

BETHE, A. 1903 Allgemeine Anatomie und Physiologie des Nervensystems. Leipzig.

BRODAL, A. 1940 Modification of Gudden method for study of cerebral localization. Arch. of Neur. and Psychiat., *43:* 46–59.

BUEKER, E. D., O. SOLNITZKY AND C. E. MEYERS 1949 Acid phosphatase reaction during the regenerative cycle of motor neurons in cats and domestic fowl after interruption of the sciatic nerve. Bulletin, Georgetown University, *3:* 59–68.

CAJAL, S. R. 1928 Degeneration and regeneration in the nervous system. London.

DAVENPORT, H. A., H. CHOR AND R. E. DOLKART 1937 The ratio of myelinated to unmyelinated fibers in regenerated sciatic nerves of Macacus rhesus. J. Comp. Neur., *67:* 483–491.

DUNN, E. H. 1912 The influence of age, sex, weight and relationship upon the number of medullated nerve fibers and on the size of the largest fibers in the ventral root of the second cervical nerve of the albino rat. J. Comp. Neur., *22:* 131–157.

EDDS, M. V. 1946 Regeneration and repair of peripheral nerves (morphological and experimental aspects). Progress in Neurology and Psychiatry. Grune and Straton, New York.

———— 1949 Experiments on partially deneurotized nerves. I. Absence of branching of residual fibers. J. Exp. Zool., *111:* 211–226; II. Hypertrophy of residual fibers. J. Exp. Zool. *112:* 29–48.

ERLANGER, J., AND J. S. GASSER 1937 The comparative physiological characteristics of nerve fibers. Philadelphia, Univ. of Pa. Press.

GREENMAN, J. J. 1913 Studies on the regeneration of the peroneal nerve of the albino rat: number and sectional areas of fibers: area relation of axis to sheath. J. Comp. Neur., *23:* 479–513.

GUTMANN, E., AND F. K. SANDERS 1943 Recovery of fiber number and diameters in the regeneration of peripheral nerves. J. Physiol., *101:* 489–518.

GUTMANN, E., L. GUTMANN, P. B. MEDAWAR AND J. Z. YOUNG 1942 The rate of regeneration of nerve. J. Exp. Biol., *19:* 14–44.

GUDDEN 1872 Experimental-untersuchungen über das peripherische und centrale Nervensystem. Archiv. Psychiat., *2:* 693–723.

HOLMES, W., AND J. Z. YOUNG 1942 Nerve regeneration after immediate and delayed suture. J. Anat., *77:* 63–96.

HUBER, G. C. 1895 A study of the operative treatment for loss of nerve substance in peripheral nerves. J. Morph., *11:* 629–740.

HURSH, J. B. 1939 The properties of growing nerve fibers. Am. J. Physiol., *127:* 140–153.

IDE, K. 1929 On the areas of the cross sections of the median and sciatic nerves of the albino rat, according to sex after osmic acid fixation. J. Comp. Neur., *48:* 373–391.

LANGWORTHY, O. R. 1933 Development of behavior patterns and myelination of the nervous system in the human fetus and infant. Contributions to Embryology. Carnegie Institution, *24:* 1–59.

LITWILLER, R. 1938 Quantitative studies on nerve regeneration in amphibia. J. Comp. Neur., *69:* 427–447.

MAYSER, P. 1877 Experimenteller Beitrag zur Kenntniss des Baues des Kaninchen-Rückenmarks. Arch. Psychiat., *7:* 539–592.

NAGEOTTE, J., AND L. GUYON 1918 Différences physiologiques entre la néuroglie des fibres matrices et celle des fibres sensitives, dans les nerfs périphériques, mises en évidence par la régénération. Comp. R. Soc. Biol., *81:* 571–574.

RANSON, S. W. 1906 Retrograde degeneration in spinal nerves. J. Comp. Neur., *16:* 265.

———— 1912 Degeneration and regeneration of nerve fibers. Ibid., *23:* 487–547.

ROMANES, G. J. 1946 Motor localization and the effects of nerve injury on the ventral horn cells of the spinal cord. J. Anat., *80:* 117–139.

SANDERS, F. K., AND J. Z. YOUNG 1944 The role of the peripheral stump in the control of fiber diameter in regenerating nerve. J. Physiol., *103:* 119–137.

SIMPSON, S. A., AND J. Z. YOUNG 1945 Regeneration of fiber diameter after cross-unions of visceral and somatic nerves. J. Anat., *79:* 48–65.

WEISS, P. 1937 Further experimental investigations on the phenomena of homologous response in transplanted amphibian limbs. J. Comp. Neur.. *66:* 481–535.

———— 1944 The technology of nerve regeneration: A review. Sutureless tubulation and related methods of nerve repair. J. Neurosurg., *1:* 400–450.

WEISS, P., M. V. EDDS AND M. CAVANAUGH 1945 The effect of terminal connections on the caliber of nerve fibers. Anat. Rec., *92:* 215–233.

YOUNG, J. Z. 1942 Functional repair of nervous tissue. Physiol. Rev., *22:* 318–375.

PLATE 1

EXPLANATION OF FIGURES

2 Exp. 1 Cross section of the right common peroneal nerve. Control for left regenerated nerve of figure 3. × 120.

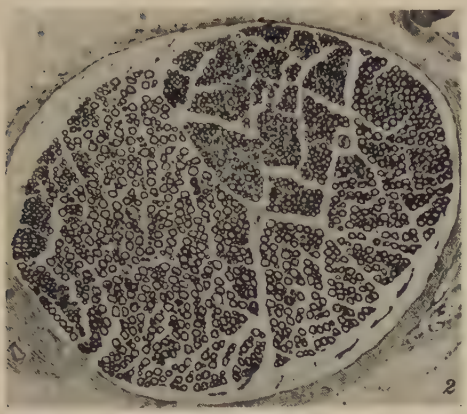
3 Exp. 1 Left sciatic nerve crushed the 4th post-natal day. Cross section of regenerated nerve at the level of the common peroneal 104 days post-operatively. × 120.

4 Exp. 6 Cross section of right common peroneal nerve; control for nerve of figure 5. × 120.

5 Exp. 6 Left sciatic nerve crushed the 10th post-natal day. Cross section of regenerated nerve at the level of the common peroneal 100 days post-operatively. × 120.

6 Exp. 15 Cross section of right common peroneal; control for nerve of figure 7. × 120.

7 Exp. 15 Left sciatic nerve crushed the 27th post-natal day. Cross section of regenerated nerve at the level of the common peroneal 102 days post-operatively. × 120.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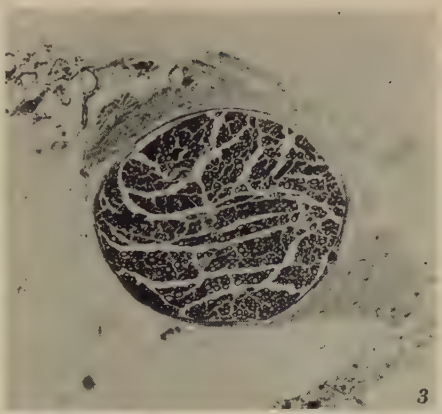
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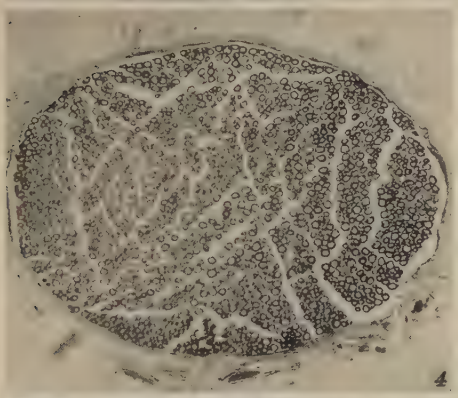
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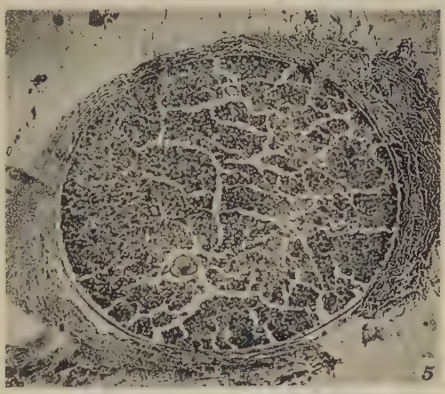
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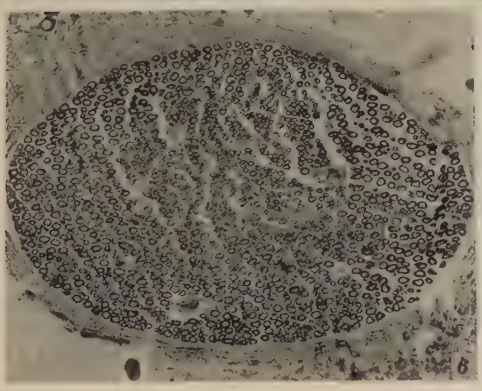
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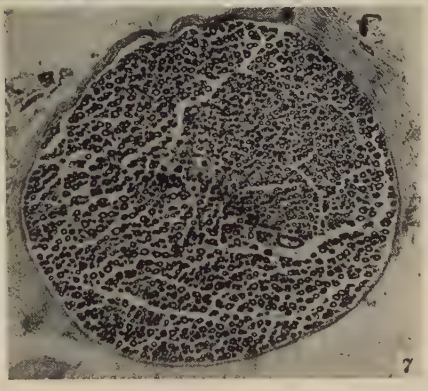
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PLATE 2

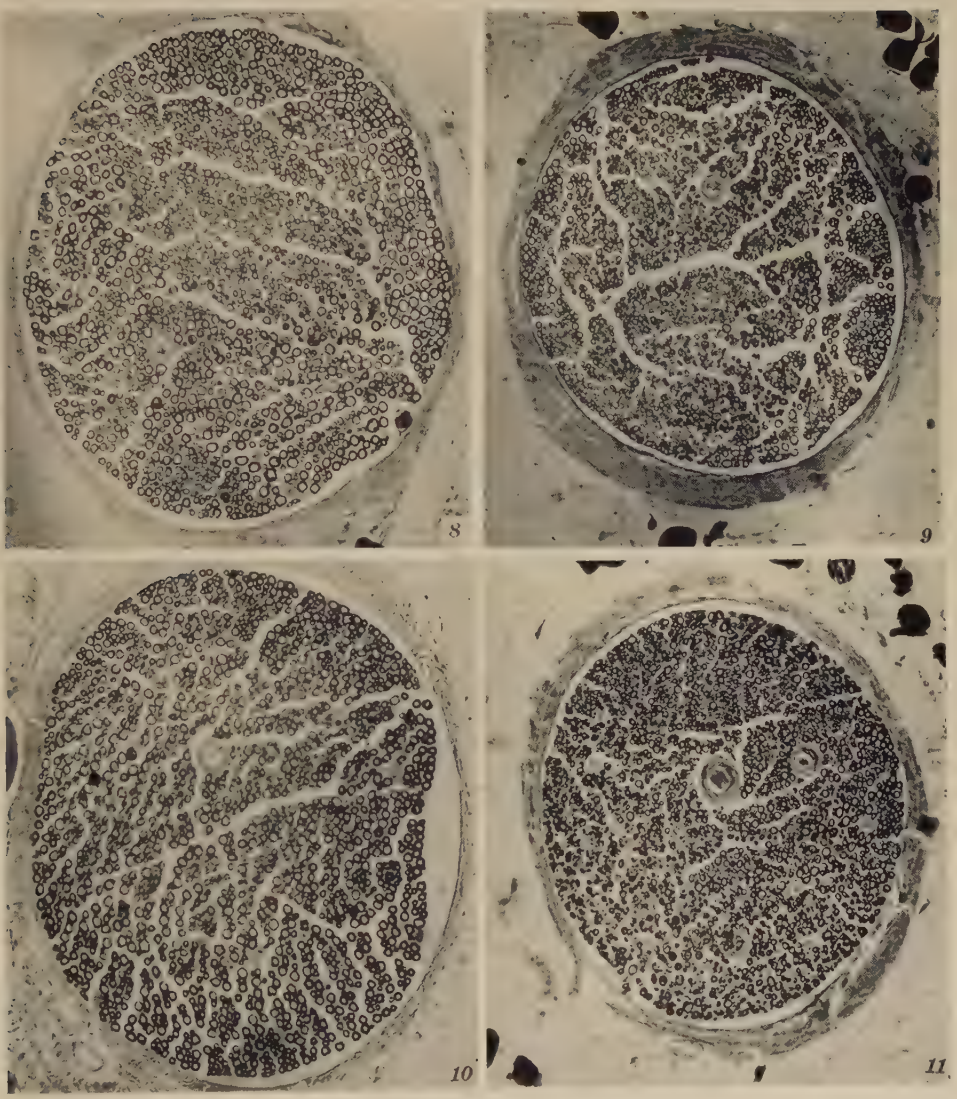
EXPLANATION OF FIGURES

8 Exp. 23 Cross section of right common peroneal; control for nerve of figure 9. × 120.

9 Exp. 23 Left sciatic nerve crushed the 44th post-natal day. Cross section of the regenerated nerve at the level of the common peroneal 100 days post-operatively. × 120.

10 Exp. 26 Cross section of right common peroneal; control for nerve of figure 11. × 120.

11 Exp. 26 Left sciatic nerve crushed the 57th post-natal day. Cross section of regenerated nerve at the level of the common peroneal 100 days post-operatively. × 160.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SECTION COMPRESSION PHOTOGRAPHICALLY RECTIFIED

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THREE FIGURES

It has long been recognized that in all types of sectioning there is deformation of the section, usually manifested in the form of compression. The basic work of Dempster ('42a, b, '43) indicating the degree of compression and the physical factors involved, was followed by Richards' ('42) comprehensive study, "The Effective Use and Proper Care of the Microtome," in which section deformation is considered in relation to general microtomy. In earlier work Aumonier ('38) had pointed out the occurrence of compression and its variation with paraffin of different melting points. He postulated an increase in section thickness resulting from the compression, which was later confirmed by Richards.

Concurrently in a different field extensive research into the physics of metal cutting, especially by Ernst and Merchant, Physicists of the Cincinnati Milling Machine Company ('40, '44, '49), revealed that friction on the tool face, seizure, plastic flow, and the resulting deformation of the chip are inherent factors in the machining of metals. Since the chip in metal cutting corresponds to the section in microtomy and since similar physical factors are involved in both processes, it appears that section deformation is inherent and inescapable. Therefore when the exact form of the section is critically important, as for instance in the precise registration required in modelling embryos from serial sections, deformation must either be accepted as a necessary evil, or ways and

means must be found to correct it. Such a means was suggested some years ago by Dr. Frederick E. Wright of the Geophysical Laboratory of the Carnegie Institution of Washington by which section compression could be rectified by optical means. The following method is based upon that suggestion.

Deformation; theoretical and practical considerations

Section compression may be clarified by reference to figure 1. Imagine this stack of cards as a microcrystalline block of celloidin-paraffin, the tool as microtome knife, the chip as a section and each circle as a microcrystal and observe how the resulting circles are deformed into ellipses. Apparently a similar movement occurs in shearing paraffin, celloidin, or combinations of both. Dempster ('42a) points out that there are two different types of shearing movements in paraffin crystals depending on temperature and plastic point. This explains the occurrence of varying degrees of compression in sections of similar thickness, a fact not understandable on the basis of melting point differences alone as described by Aumonier.

We have found in this laboratory that minimum compression occurs when the material is doubly embedded. Apparently the combined paraffin-celloidin matrix is less sensitive to thermal variations than paraffin alone, and shears with less internal displacement.

A typical procedure, which as shown by our experience produces minimal deformation, involves embedding in either 8% Schering Celloidin or 8% Lindsay Light (12 oz. guncotton)[1] cleared in Cedar Oil and infiltrated with 50–52°C. Fisher Tissuemat is as follows: the block after hardening is accurately trimmed and is sectioned with a standard Spencer No. 860 Precision Sliding Microtome using the same company's No. 945 microtome knife with a clearance angle of 3°, facet bevel of 22° and rake 65°. The average tempera-

[1] Lindsay Light & Chemical Company, West Chicago, Illinois.

ture in the vicinity of the block with an incident beam of light falling on the block's surface but with the infra red rays filtered out, is about 25°C. Another important procedure that results in minimal section compression is the "Water-on-the-knife-method" (Huber, 1898; Heuser, '37), which is routinely used in this laboratory for serial sectioning. Under

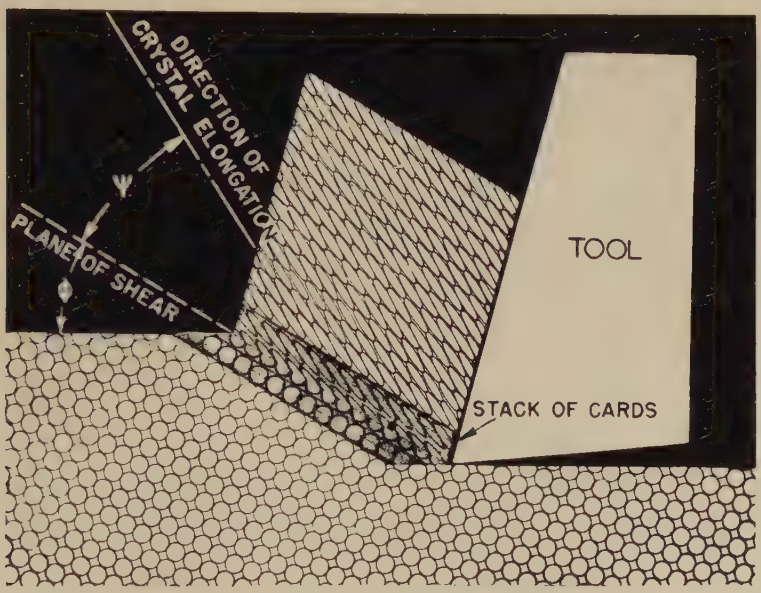

Fig. 1 Schematic diagram of the mechanics of chip removal in metal cutting which helps to clarify the physics involved in sectioning in microtomy. The included angle of the tool, i.e., the knife, would be approximately 48° less than is shown in the figure, while the plane of shear would be nearly vertical in a typical set-up for microtomy.

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the conditions operating in either of these procedures the least compression is 7% in the direction of knife movement, although it at times amounts to as much as 20%, depending upon the thickness of the sections, all other factors being constant.

At the Carnegie Embryological Laboratory our attention has been strongly directed to distortion of serial sections by

compression, by reason of a special method used in the orientation of sections preliminary to reconstruction by our modification of the Born waxplate method. It is our custom, when sectioning valuable small embryos, to record each section or rather "potential section" in undistorted form by photographing the top of the block in the microtome as each successive section is removed by the knife. These photographs, which are made in series on 35 mm film, bear marginal notches which fix the orientation of each section. After the sections are mounted and stained, they are again photographed, at a larger magnification on bromide paper. Each of the bromides in sequence is pinned upon a board and the corresponding 35 mm photograph made from the top of the block is projected upon the bromide, at the same magnification. After the two images are made to correspond in outline as far as possible, lines are drawn upon the bromides from the notch-marks of the film-strip image, thus providing permanent guides for orientation when the bromides are traced upon wax plates in the process of modelling. The whole method has been described by Heard ('31).

The statement made in a previous paragraph as to the amount of compression in doubly embedded material is based upon the same study (Heard, '31) which shows that measurements made from photographs of the top of the block of potential sections, just before cutting, do not agree when compared with photomicrographs of the same sections after they have been mounted and stained. This lack of congruence is a cause of difficulty in the procedure for placing orientation lines on the photomicrographs. To improve the matching of the two images it was found necessary to tilt the board carrying the bromide print upon which the other image is projected. Coincidence throughout the entire area of identical sections was never obtained but by matching structures falling in one plane more accurate orientation was obtained than previously. Numerous reconstructions have been made by this method and Heuser ('30) attests the usefulness of the method.

Recent work on section compression emphasizes the need for still greater accuracy in reconstructions, especially when undistorted forms and volumetric data are required. The following technique was used to compensate for section compression. Although theoretically imperfect it eliminiates gross defects.

Geometric optics of the procedure

It is assumed that any properly figured anastigmatic lens will project a rectangle with uncurved sides and that the rays throughout any circumference within the angular field of the lens will be of the same length, color being neglected. The lens indicated in the scheme figure 2-A forms an image of parallel lines falling on area *a a′b b′* which is rotated from a vertical plane at right angles to the optical axis. Since the rays *ab* are shorter than *a′b′* the magnification varies depending on the inclination of the plane. Area *c d c′d′* is rotated from a vertical plane and also moved obliquely with respect to the optical axis; therefore, *d′* has a greater magnification than *c′*. The area *f e f′e′* is represented as lying at right angles to the optical axis and is therefore undistorted and uniformly magnified. These planes represent an elementary condition in projection optics and require no further elucidation. Any photographer who tilts the back of his camera to compensate for perspective distorted by an awkward lens angle, or who tilts the copy board in enlarging to correct architectural distortion employs the above principle. If one moves a plane from the normal, i.e., away from right angles to the optical axis, and if the angular displacement does not exceed the depth of focus in relation to the inverse proportion of the first power of the diameter of the aperture of the lens, the image will appear sharp.

Scheme for rectification of the image of the section

In applying the above principle to the problem of photographically reducing section compression, a large Bausch & Lomb horizontal photomicrographic apparatus was used

with a special attachment to the lens housing, consisting of a revolving sleeve mounted on the housing to which a first surface mirror A (fig. 2-B) was attached. This mirror could be rotated as well as tilted in required obliquity to the normal opitcal axis. Another first surface mirror B was mounted on

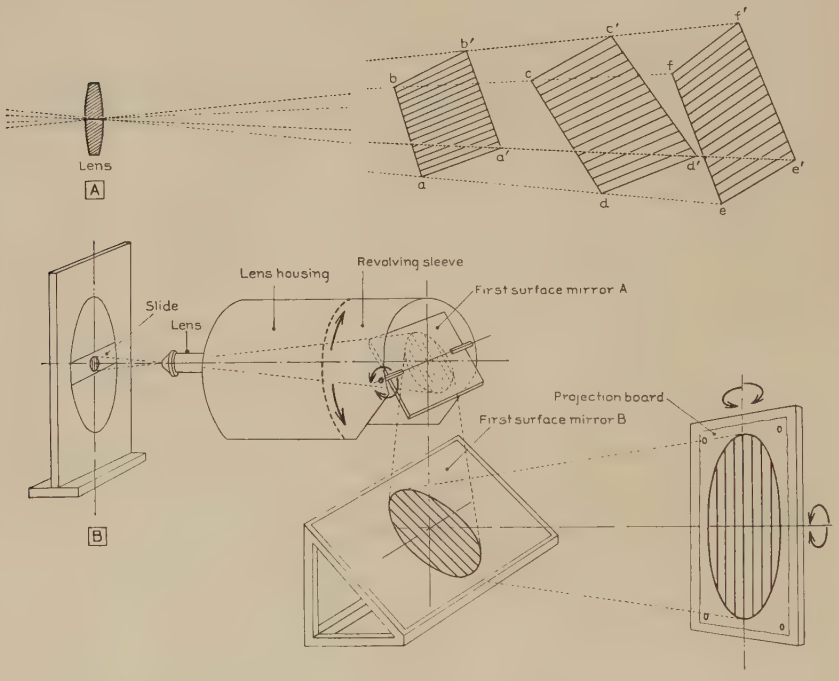

Fig. 2 Scheme for section rectification. *A* represents the geometrical optics involved with the images of a screen with parallel lines distorted in areas bounded by *a a'b b'* and *c c'd d'*. The area *e e'f f'*, at right angles to the optical axis, is undistorted. For clarity of presentation the three areas are separated instead of being superimposed. *B* represents a schematic diagram of the arrangement of adjustable mirrors A and B with copy board mounted on a universal joint.

the optical bed of the apparatus in such a way that it could be moved parallel to the conventional horizontal optical axis. This back-and-forth adjustment of mirror B along the optical bed was necessary since the reflected image from mirror A moved from the true vertical by virtue of the tilting of mirror

A. The copy board carrying the partially rectified image was mounted on a universal joint and could be tilted in any direction.

An outline based on the original photographic record made of the surface of the block at the time of section was used at a determined magnification. This magnification was obtained from a surface-graduated stage micrometer which was routinely photographed onto each serial orientation record. The micrometer image, and the serial images, were enlarged to the required magnification without distortion by conventional photomicrographic procedure. Either Zeiss Planars or Bausch & Lomb Micro-Tessars were used to form the undistorted images. In practice, an undistorted image of a potential section was projected to the copy board and the corresponding mounted section was then projected through the system of mirrors. The first surface mirrors A and B were adjusted as for an undistorted image with the copy board normal to the optical axis and at the required distance until the projected image roughly coincided with the undistorted outline; then by adjustments of mirrors and copy board the two images were made to coincide.

Rectified and modified photomicrography

To obtain rectified photomicrographs of serial sections it is necessary (1) to have a record of the overall dimensions of the block containing the specimen, or better still (2) to photograph the top of the block as described above, or (3) to use the Hegre-Brashear ('46) method of surface staining tissue in the block as a means of control for size. Unless there is an exact record of the dimensions of the block or a precise measurement made of the mounted sections before the paraffin is removed, there is no way to check the amount of compression and therefore no means of knowing the size to which the image should be rectified. It is generally assumed, and years of work devoted to embryological reconstructions bear it out, that the distortions in serial sections are in the

same direction as the forces introduced when sectioning, and that if uniform conditions are maintained in sectioning and mounting, the successive serial sections are similarly distorted. Otherwise reconstructions would be of limited usefulness. The amount and direction of compression thus being relatively uniform, it can be assumed that if an average section of the series is selected to serve as criterion of the

Fig. 3 Photomicrographs of human embryo No. 8119 section 3–5–4 magnified 20 × ±. A is the 7% compressed section; B is rectified without compression effect; C is elongated 18%; D is broadened 25%. The widths of B and C, indicated by the arrows, are identical in magnification and at the same level in the section, B and C are used to illustrate the possibilities of the method where compression is excessive. Photomicrographs made with Carl Zeiss 20 mm Planar 1:4.5 with full aperture.

amount and direction of compression, one has only to set the mirrors and copy board, and photograph the entire series with the determined amount of rectification.

The degree of compression met with in a typical specimen in the Carnegie Collection, No. 8119, may serve to demonstrate the possibilities of the procedure. Figure 3 represents section 196 3–5–4, i.e., the 196th in a series of 540 sections

cut at 8 μ on a Spencer Precision Sliding Microtome from a doubly-embedded block that was compressed 7%. Figure 3, A represents the section conventionally photographed; B represents the rectified image adjusted to coincide with the undistorted potential section as photographed from the top of the block when cutting the series; C represents an elongated image 18% longer than A but adjusted so that the width is identical through the level of the section indicated by the arrows; D represents an image in which the width has been increased 25%, whereas the length has been maintained as in the rectified B. In all three modified images B, C, D, note that they are in focus throughout and it is evident we have not exceeded in any case the angle involved in the depth of focus relationship mentioned previously. All 4 photomicrographs were made with a 20 mm Zeiss Planar 1:4.5 with the diaphragm wide open. C and D are included to show the effects of overcorrection.

Moreover it was found that isolated portions of sections from different series did not always agree. This was attributable to irregular spreading of the sections at the time of mounting on the slides. Sections with unconnected portions frequently showed greater discrepancies of this kind, which were more marked in paraffin-embedded specimens than in sections of doubly-embedded tissues. Using our method of rectification under the guidance of an original undistorted image of the potential section it is possible to correct the displacement and distortion of isolated parts of sections, permitting precise three-dimensional reconstruction of specimens, perhaps unique and irreplaceable, which could not otherwise be correctly modelled.

The method can be used by the embryologist interested in comparative quantitative studies or in morphological studies that depend on serial sections. Serial sections photographically rectified show much less optical than mechanical deformation. Several specimens used to check the experiment generally conformed throughout to the undistorted images. Hence the application to embryological reconstructions should

yield far more accurate models. It must be re-emphasized that the practical application of the method depends on either obtaining accurate measurements of the block before sectioning and in each case checking the amount of compression and its direction or else on the use of serial photographs of the top of the block.

The method, moreover, can be used in fields other than embryology where serial sections are employed. Indeed, most microscopists are unaware of the artifacts introduced by the technician in sectioning. Deformation of the section, inherent and inescapable as it is, may not be entirely eliminated by this method but it can be largely corrected.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to Dr. Wright, who suggested the method and who has read the manuscript, to Mr. James F. Didusch for drawing figure 2 and to Dr. Merchant for permission to use figure 1. He is also indebted to Mr. Richard Grill for photographic help.

LITERATURE CITED

AUMONIER, F. J. 1938 Notes on the distortion of paraffin sections. J. Roy. Micr. Soc., *58:* 253–257.

DEMPSTER, WILFRED T. 1942a The mechanics of paraffin sectioning by the microtome. Anat. Rec., *84:* 241–267.

———— 1942b Distortions due to the sliding microtome. Anat. Rec., *84:* 264–274.

———— 1943 Paraffin compression due to the rotary microtome. Stain Technology, *18:* 13–24.

ERNST, HANS, AND M. EUGENE MERCHANT 1940 Chip formation, friction and finish. The Cincinnati Milling Machine Co., Cincinnati, Ohio.

HEARD, OSBORNE O. 1931 A photographic method of orienting serial sections for reconstructions. Anat. Rec., *49:* 59–69.

HEGRE, ERLING S., AND A. G. BRASHEAR 1946 Block surface staining. Stain Technology, *21:* 161–164.

———— 1947 Block surface staining. Anat. Rec., *97:* 21–28.

HEUSER, CHESTER H. 1930 A human embryo 14 pairs of somites. Carnegie Inst. of Wash., Publ. no. 414, Contrib. to Embryol., *22:* 135–153.

———— 1937 McClung's Handbook of Microscopical Technique, p. 623.

HUBER, CARL 1901 Am. J. Anat., vol. I, no. 1, p. 45.

MERCHANT, M. EUGENE 1944 Basic mechanics of the metal-cutting process. J. Applied Mechanics, September, pp. A-168–A-175.

———— 1949 Metal Cutting Research Theory and Application. "Machining — Theory and Practice," American Society for Metals.

RICHARDS, OSCAR W. 1942–1949 The effective use and proper care of the microtome. American Optical Company, Scientific Instrument Div., Buffalo 15, N. Y.

AN EXPERIMENTAL STUDY ON THE GENERAL UTILITY OF CONCENTRATED (COMMERCIAL) FORMALIN AS A FIXATIVE

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Formalin is universally utilized as a fixing reagent but almost entirely as a 10% dilution. Having previously found concentrated (commercial) formalin far superior to the 10% solution as a fixative for staining with silver methods on spinal cord axons (Lassek and Powers, '47), we have investigated its fixing potentialities on a variety of tissues and stains.

The organs tested in a large number of cases are the following: liver, stomach, bladder, heart, kidney, intestine, spinal cord, muscle and pancreas taken from cat, monkey and man but mostly from the first two. Hematoxylin and eosin, trichrome, van Gieson, Mallory, Weil, cresyl-violet, carmine and silver methods are the staining procedures tried. Identical pieces throughout were treated with both concentrated formalin and the 10% solution, the latter serving as controls.

Concentrated formalin, which has a pH of about 3.4 and a high specific gravity, is found to be a rapid fixing medium for all the organs tested. It penetrates quickly so that complete fixation occurs through all parts of a relatively large block by 5 hours. In this respect, it matches Zenker's fluid. After 3 to 5 hours fixation, the pieces which initially float due to the high specific gravity gradually sink to the bottom of the receptacle and this is judged to be a criterion as to fairly

thorough saturation. These characteristics do not apply to 10% formalin.

Presentable sections stained with hematoxylin and eosin have been obtained following one hour's immersion in concentrated formalin and minimal dehydration in dioxan (4 hours) or alcohol (24 hours). Both of these dehydrating solutions also fix to some extent. On experimentation, dioxan by itself was found to fix incompletely over a 4-hour period indicating that concentrated formalin has considerable fixing power in a short period of time. Fixing durations of less than 5 hours, however, are not recommended. Prolonged fixation over several months in formol does not harm the tissues for subsequent successful embedding, cutting and staining.

The fixing process in concentrated formalin is such that it creates a sturdy, firm block which cuts well irrespective of variations in the room temperatures. Although no actual scientific measurements have been made, it is our impression that there is less shrinkage than that which occurs in 10% formalin.

Some slight differences have been noted in the response of stains following concentrated and diluted formalin fixation. In the hematoxylin and eosin technic, the hematoxylin goes in faster and the eosin slower after immersion in concentrated formalin so that the time factor has to be slightly altered to obtain similar pictures. With the other staining technics employed, it is almost impossible to detect any significant variations in the staining reactions between the tissues fixed in either the dilute or concentrated fixatives.

Concentrated formalin is a very excellent fixative for the staining of axons in the central nervous system by silver methods being far superior to the 10% solution (Lassek and Powers, '47). In this field, it appears to be one of the finest fixing reagents. We have since tried hundreds of experiments adding various combinations and percentages of all the basic fixing solutions to formol but without notable improvement in the silver response. Cresyl-violet, hematoxylin and eosin and carmine stain well on cord tissue but in the Weil technic for

myelin sheaths concentrated formalin gives slightly less favorable results than 10%.

It is not intended to suggest that concentrated formalin is an ideal all-around cytological fixative but in situations calling for formalin treatment either in experimental or pathological tissues, it is believed that it offers a more speedy and thorough fixation than does the 10% mixture and yet gives about the same staining possibilities. It surpasses the latter for axonal staining with silver or other methods.

CONCLUSIONS

We believe that concentrated formalin has the following characteristics as a fixing reagent: It has a stable pH, it does not cause precipitations, it has a relatively powerful speed of penetration and it creates a sturdy block of tissue which gives maximal ease of cutting. It also produces minimal or no shrinkage and it fixes in such a way that the staining possibilities are about the same as for 10% formalin. It is a superior fixing medium for the application of silver nitrate on axons in the central nervous system, particularly in the spinal cord.

LITERATURE CITED

Lassek, A. M., and Margaret M. Powers 1949 Concentrated formalin versus a 10% solution as a fixative preceding silver staining. Stain Technology, *24:* 33–37.

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